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## THE SUGAR COMMISSION.

DURING recent years the downward trend of sugar prices has caused much anxiety, not only in the West Indies but in the sugar world in general. With the exception of a partial recovery in the season 1926-27 prices have fallen steadily and have now reached a level which suggests that the industry is suffering from a severe crisis. Already steps have been taken to survey the world position by the Economic Committee of the League of Nations which recently published its report and conclusions whilst the chief producing countries have had preliminary discussions on the situation. The British Government, aware of the dangers of a possible failure in the staple industry of the West Indies have, on the other hand, appointed a Royal Commission, under Lord Olivier, whose terms of reference are, to say the least, extremely comprehensive. The examination that they are proposing to carry out will be anything but cursory and if the work contemplated is done as thoroughly as it was by the 1896 Commission, then there is every reason to anticipate that some extremely valuable information will be collected on the present economic position of the West Indian colonies concerned. Indeed, such a searching enquiry will not only provide new facts about the development of the industry since the sitting of the first Commission but will bring up to date the agricultural history of the West Indies and the results which have accrued as a consequence of the adoption of the recommendations of the last Commission. In addition, it should reveal the conditions underlying the present state of affairs and be extremely useful towards formulating plans which may help to alleviate the present distress.

To turn to the task of the present Commission. Apart from an enquiry into the general outlook of the industry the members are to investigate how far the causes of the present depression are temporary or permanent and to consider the financing of all possible measures, temporary or otherwise, which will place the industry on the best possible footing. They are, further, to enquire also into the advisability and feasibility of replacing sugar by alternative crops and into any schemes of migration of labourers or land settlement. These, the main terms of reference may be briefly elaborated as follows. The Commission, when they arrive, will already be in possession of the facts relating to the general causes of the depression but will require to

supplement these facts with information regarding local causes. These will be discussed in the light of the incidence of pests and diseases, labour supply, failure of the markets, climatic disturbances and the efficiency of the existing systems of peasant cultivation, estate and factory organisations. Details will be wanted on acreage, yields, costs and output. Remedial measures will be considered on information relating to research and improvement in cultivation, on statements of the use made of the grants recommended by the previous Commission and on the existing arrangements for poor relief and of any financial difficulties that may be threatened in connection with the question of providing employment and relieving distress. Information will also be desired on the incidence of taxation, on the distribution of labour, on rates of wages and on locally grown and imported food supplies, while past experience and statistics may help to throw light on the problem of alternative crops. Barbados, Antigua and St. Kitts will be expected to provide data on possible schemes of labour migration and on the extent to which their labour is now seeking employment elsewhere and of the attitude of other Governments towards such immigration. British Guiana, on the other hand, will have to supply information on the probability of developing settlements attractive to immigrants. Thus may be summarised the functions of the Commission which will, naturally, hold a number of formal sittings for evidence and discussion and also visit the most important and typical centres of sugar production.

Before offering comments with regard to the Commission's main objects it might be advantageous to look into the general causes of the present depression. The history of its origin was reviewed in our columns ([1]) in 1926 and need not therefore be reiterated here. In the last three years, however, far reaching developments in the world sugar industry have occurred which have upset all calculations. Briefly, the industry has had to struggle against excessive supplies despite a rapidly increasing demand with prospects for producers to-day only a little brighter. Restriction in Cuba was only partially successful in raising prices during the season 1926-27 chiefly because Java had already taken advantage of increasing her production. In spite of the still more drastic restriction of the Cuban crop, world production increased by 1.8 million tons in 1927-28. Consumption also increased but not, however, sufficiently to prevent a further small addition to an already enormous carry over. Nor did the complete abandonment of restriction in Cuba last year help to mend matters as for the current season the production figures can hardly fail to be at least 1 million tons greater. It is no wonder therefore that prices have remained at such an extraordinary low level.

Although the present Commission's work will be confined to the West Indian Sugar industry it is possible that some attention may be paid to Imperial cane sugar production as a whole. This, at present, totals over 4½ million tons. Most of this sugar is consumed locally but about ½ million tons finds its way on the British market. Some useful result might be forthcoming from a consideration of the possibility of the formation of an Imperial sugar pool in London. Such a pool, with branches, say, in importing countries like Canada, might function successfully along the lines of the Cuban single selling agency or the Canadian wheat pools. In support of this it might be mentioned that in Australia special action has already been taken to assist the Queensland industry by allowing each mill to produce up to its highest output in any year since 1915. All sugar produced up to this limit goes into a No. 1 pool and is sold locally under existing arrangements by the Australian Sugar Board. Any surplus forms a No. 2 pool and is sold separately by the Board in London. Thus postulated, the Imperial sugar pool would merely fulfil the function of the No. 2 pool for all cane sugar including surpluses produced by the British Colonies.

Again, there is plenty of scope with regard to increasing the *per capita* consumption of sugar by suitable propaganda. It is surprising to find, for instance, that the consumption per person of sugar in Australia is 130½ lb. as against a world average of 30 lb. and European and American averages of 40 lb. and 78 lb. respectively. Propaganda, however, is a matter of funds of which unfortunately, most sugar producers are desperately short of at the present time.

In this connection there is also the possibility of introducing alternative commercial uses for sugar which for example, has been found in some cases to be better than salt for preserving meats and other foods. It can also be used as an ingredient of various explosive materials and in the manufacture of transparent soaps, pure carbon, artificial diamonds and liquid glue and for medicinal purposes. It is a raw material for alcohol, a number of acids, artificial silk celluloid and many other things. It would seem therefore, distinctly worth while to carry out organised research on a reasonably large scale to discover new industrial uses for sugar.

With regard to production, the industry in the West Indies is probably capable of improvement. It may be possible, for instance, to strengthen the present organisation of the factories by further centralisation, and by introducing more up-to-date machinery and equipment and cheaper methods of transport and marketing. In any case, spectacular cuts in the managerial and technical staffs of an enterprise should be avoided. If anything, supervision should be tightened and research stimulated by the appointment of first class men, whose knowledge and ability would help to keep an enterprise going during difficult times and tide it over the period when, under the inexorable influence of economic laws, the less efficiently managed businesses will go into liquidation.

In the field it may be advantageous to introduce new varieties of high yielding canes and rotation crops to improve soil conditions where sugar has been grown as a continuous crop for a number of generations. The possibilities of using larger quantities of artificial manures require investigation in particular and the uses of modern implements might also be stimulated. Increased yields per acre would help considerably towards reducing costs of production. In short, it seems that the time has arrived when research work should be concentrated on the field rather than on the factory. If figures (2) are in anyway reliable, Java appears to hold first place with regard to cheapness in production although Cuba and Trinidad are not very far behind. It should be pointed out, however, that where fiscal measures are concerned the position of the Sugar industry in the West Indies is very greatly strengthened by the fact that they produce sugar at a much lower cost than any other parts of the British Empire.

Again, the present shortage of labour in certain of the West Indian colonies will afford a great opportunity for the Commission to devise some satisfactory system of migration, specially into British Guiana—a problem which is inseparable from that of the local production of food supplies.

Confronted with many difficulties as the Commission will undoubtedly be, it is certain that much useful information will be collected. The full co-operation therefore of all those who are in a position to assist the Commission in the elucidation of the problems which it is about to tackle, will go a long way towards achieving its aims. In conjunction with the several Departments of Agriculture, the Imperial College will willingly render all possible assistance, and, in the future, if necessary, will be prepared to carry out further investigations into the problems of the West Indian sugar industry.

(1) *Tropical Agriculture* July, 1926.
(2) The Sugar Industry of the British West Indies and British Guiana with special reference to Trinidad, by C. Y. Shephard.

## WEST INDIAN AGRICULTURE.

### Agricultural Conference.

IT will be remembered that a resolution was passed at the 1929 Standing Conference of the British West Indies to the effect that a Conference of Directors of Agriculture of British Possessions in the Caribbean should be held in Trinidad under the Chairmanship of the Principal of the Imperial College of Tropical Agriculture, mainly to devise means for co-ordinating local programmes of agricultural and veterinary research work. The following Governments have intimated their willingness to co-operate in the proposed Conference: Trinidad and Tobago, the Leeward and Windward Islands, British Guiana, Barbados and Bermuda. Both British Honduras and the Bahamas, although expressing their approval of the scheme, will however, be unable to send representatives to the Conference. A programme will be arranged by the Chairman on receipt of research programmes and suggestions from the various Colonies. It has been suggested that a suitable date for the Conference would be from 23rd to 29th January, 1930, as these dates coincide with the sailings of the Canadian National Steamships and should, therefore, prove convenient to representatives from the majority of the Colonies.

## SOUTH-WEST AFRICA.

### Nitrate Deposits.

AN important announcement in connection with nitrate supply was made before Section B (Chemistry) of the British Association meeting in Capetown by Prof. J. Smeath Thomas, of the University of Capetown. While being extremely cautious and avoiding any definite statements not substantiated by facts, he stated that there appeared to be in South-West Africa an area of at least 10,000 square miles of nitrate deposits ranging from 2 per cent. to 20 per cent. sodium nitrate. These deposits have been traced in the Gibeon district, an arid plateau 3,000 to 4,000 feet above sea level, from 50 miles to the east of Mariental on the railway line towards the Kalahari desert. This plateau is traversed in a south-easterly direction by three dry river beds at a distance of about 100 miles apart, and nitrate has been found in the cliffs bordering all 3 river beds. He emphasised that these outcrops alone had so far been investigated, but the geological formation was entirely favourable to the existence of a continuous belt of nitrate throughout the region between the river beds, and beyond. The depth of the deposit was variable—in some places nitrate was found from near the bottom to near the top of the cliff.

These deposits which are regarded as primary deposits, will, it is believed, become richer if worked inwards, but this has not yet been proved. Apart from these rock deposits there is an enormous amount of a much richer deposit at the base of the cliffs in the river beds. This is regarded as a secondary deposit which has been formed by denudation and erosion of the exposed cliffs. All samples tested contained between 40 per cent. to 86 per cent. sodium nitrate, had a low phosphate content, and were very free from iodine.

With regard to facilities for working it was stated that although the country is arid there is plenty of water underground. Boreholes have already been sunk at many points, and these have indicated that a supply of 12 million gallons per day is available at a depth of 200 to 400 feet. No transport difficulties are anticipated as there is a railway within 50 miles.—(*Chemistry and Industry*, Vol. XLVIII, No. 34.)

# SOILS AND FLORA.

## Notes on a Botanical and Soil Inspection of the St. Lucia Banana and Forest Lands.

BY C. W. WARDLAW.

### I. Introduction.

THE writer, in pursuing the investigation of Panama Disease of bananas, first visited the banana lands of St. Lucia in May and June, 1928. The results of that visit, from the pathological standpoint, have been briefly set out in a Report to the Empire Marketing Board (9), while in two papers recently published in this Journal E. A. Walters (7, 8) has discussed the island's banana industry and submitted some observations on adverse soil changes resulting from the system of banana growing practised on the steep hillsides of the rain-forest region.

When carrying out field investigations on the abandonment of banana lands in Central America it gradually became evident to the writer that two factors were involved, namely, (1), actual disease caused by *Fusarium cubense* (the causal organism of Panama Disease), and (2), progressive soil deterioration due to a variety of causes set in motion by deforestation and by the continuous system of cropping usually employed, various aspects of which have been discussed in a recent issue of this Journal (10).

In St. Lucia, the rain-forest region is broken and mountainous, with steep hillsides and deep ravines. In such country, where even the best soils are not of the first order of fertility, soil deterioration, in the absence of suitable methods of conservation, proceeds rapidly, and in the short space of five years a well marked series of changes may take place, affording favourable material for ecological observations. In order to gain further insight into these questions a second visit was paid to St. Lucia during June and July of the present year, when botanical and soil inspections were carried out on the abandoned banana lands and on a number of cultivated and forest areas. One object in view was to compare the relative fertility of the land under different systems of vegetation. Such cursory examination does not, of course, supply exact data regarding soil composition, but when comparative soil inspections are coupled with an ecological study of the flora much useful information regarding the relative fertility of areas under different agricultural or natural systems may be obtained. Indeed it is on such data that the agricultural pioneer has mainly to depend, and instances are not wanting where the neglect of a survey has proved exceedingly costly. In this article the writer has set down his impressions of soil changes based on such a botanical and soil inspection.

While the observations recorded here were chiefly made in relation to banana research, the broad inferences may also be found applicable to other crops that are exacting in their soil requirements. Again, such information, while mainly culled from St. Lucia is not without wider analogies. Thus land conditions in St. Lucia are by no means dissimilar to those of the hilly areas in Central America, where banana failures very comparable in their major aspects to those of St. Lucia have taken place (9), while in Jamaica (4) similar problems of soil conservation in some of the hilly districts have attracted considerable public interest.

### II. Present state of banana lands.

The history of the banana industry and the nature of the country utilised have been described at length by E. A. Walters (7) and need only be briefly mentioned here. Crown forest land, in the rain-forest central region of the island, at an elevation of some 400 feet, with rainfall of 100 inches, was taken over for broad-scale banana growing at the end of 1922. The promoting company became insolvent at the end of 1926, and the banana lands were thereafter abandoned.

The island as a whole is volcanic, and its central portion is hilly and broken, with moderately steep slopes running down to deep ravines. The streams, flowing over rocky beds, are indicative of an advanced state of denudation. The virgin soils vary according to the exposure of the land, weathering and vegetation, but fundamentally are formed by the disintegration and accumulation of volcanic materials derived from the original igneous agglomerates, tufas, breccias, and grits (1). According to the type of weathering these soft volcanic rocks give rise *in situ* to red or yellow loam-like clay soils which are further modified by the amount of organic matter present.

To the eye of the agriculturist the abandoned banana lands of St. Lucia to-day present a depressing spectacle. The entrance to the Ravine Poisson, originally the nursery for producing planting material is now a grass-grown barren waste, with an occasional short-lived peasant's "garden." The roadways and tracks, cut out from the steep hillsides at very considerable expense, are now overgrown with bush, and here and there obliterated by land-slides. Up the Ravine Poisson the path is greatly overgrown by rampant bush and tree ferns, blocked by dislodged trees, and displaced by land-slides. This was originally a fairly productive area but, owing to the rough and steep nature of the country, upkeep must have been exceedingly difficult, while bringing out fruit was troublesome and entailed a disproportionate amount of toil. The soil in its virgin state was fertile, and where it had accumulated in pockets very good fruit was obtained. In the course of a few years, however, high precipitation, rapid and extensive soil erosion and depletion of organic matter, coupled with the lack of any adequate system of conservation, have led to marked soil deterioration. The Gros Michel banana, which requires good soil conditions to flourish, thus finds itself in open competition with a native weed flora less exacting

## SOILS AND FLORA.

FIG. 1.—*The banana lands of the Ravine Poisson, St. Lucia, as they are to-day. Gros Michel plants are growing in unfavourable competition with Tree Ferns (Cyathea sp.) and Trumpet Tree (Cecropia palmata).*

FIG. 2.—*Typical vegetation of road-sides and eroded soils in the banana lands. The poor soil is populated by Ferns (Gleichenia sp.), Lycopodium cernuum, and seedlings of Miconia—plants which are inexacting in their soil requirements.*

## SOILS AND FLORA.

Fig. 3.—*Banana lands in the Vanard district. All the land in the foreground was planted with banana in 1924. Five years later the bananas are practically obliterated by a rampant weed flora of bush, Trumpet Tree, &c. Primary forest is seen in the background.*

Fig. 4.—*Cendre d'Cie banana land, St. Lucia. The remaining bananas are now being overtopped by Tree Ferns (Cyathea), and bush (Miconia), while the Trumpet Tree is beginning*

in its requirements, and is slowly being ousted. The dominant weed flora (secondary flora) which has appeared in the Ravine Poisson plantations consists of *Cecropia palmata* (Trumpet tree), *Sciadophyllum* (an Araliad) and *Cyathea sp.* (a tree fern).

Together with the Gros Michel these now constitute a dense impassable vegetation on the steep hillsides where originally orderly plantations had been established. In 1928 the tree ferns were more or less of equal stature with the bananas, while *Cecropia* and *Sciadophyllum* rose a few feet above the general level of the vegetation. This year the latter two species in some areas have grown almost to tree-like stature while the tree ferns now overtop the bananas. On some hillsides the spreading banana foliage is still relatively conspicuous, but on others it has been overgrown and obliterated, and the plants will slowly become attenuated as the overhead canopy of the secondary vegetation increases.

In sheltered and fertile gullies or other areas where the loose soil has accumulated, the Gros Michel still holds its own and bears fruit in spite of active competition for the land. Such clumps may conceivably persist for many years, and are suggestive of the habitat of the banana in its natural state. In the Ravine Poisson and higher up on the slopes of Mt. Lacombe the nature of the land is such as to make any agricultural undertaking difficult. In its original state under forest conditions the soil was relatively good, but there can be little doubt that during the last few years, considerable deterioration has taken place, as the result of erosion, land-slides, exposure and depletion of organic matter. At the present time on the hillsides the Gros Michel only succeeds in developing a shallow and inextensive root system, and, therefore, quite apart from disease, under such adverse conditions a brief period of production is inevitable. The present indifferent quality of the soil is indicated by the obliteration of the banana and the encroachment of a poor type of secondary vegetation.

In the Cul-de-Sac Crown Lands, opened in 1923 and abandoned in 1926, the country consists of steep hillsides dissected by gullies. In the latter the Gros Michel is still holding its own, but on the open hillsides between the gullies, the plants are being overgrown by bush of which a species of *Miconia* is dominant. From a distance this hillside area presents an interesting impression of the relation of the Gros Michel to its surroundings. Where soil has accumulated in pockets or has not been displaced, a moderate stand of plants is still found, but where topography makes for soil deterioration the plants soon find themselves in unfavourable competition with the secondary weed flora. The latter consists of bush of a poor type, inexacting in its requirements, and indicative of poor soil.

Adjacent to the Ravine Poisson are the Crown Lands of Cendre d'Cie and Vanard. These were also planted in bananas in 1924 and abandoned in 1926. Here again bananas on the exposed hillsides are overgrown by *Cecropia*, *Sciadophyllum*, and *Cyathea*, while occasional groups of good plants are still prominent in localised favourable spots. In all these districts one cannot fail to be impressed by the close relation between the survival of the Gros Michel and the quality and condition of the soil. A brief description of some of the soil types is given by E. A. Walters, (7, 8).

To summarise : in St. Lucia we have an example of an attempt to establish a crop on land which not only presents topographical difficulties, but is also unsuited, except in local areas, for continuous banana growing. Thus, for a few years of banana production, a considerable area of virgin forest land has been destroyed, and the banana, finding itself in unfavourable competition with a rampant secondary flora, not so exacting in its requirements, is rapidly being obliterated. These changes are definitely associated with soil deterioration.

### III.—Peasant Gardens.

As a rule it is easier to observe, from many indications, that soil deterioration has taken place than to explain the nature and extent of the factors operating to produce this change. In order to throw further light on this question the writer followed up his inspection of abandoned banana lands by a comparable study of "peasant gardens," either bearing their scanty crop or abandoned for a shorter or longer period of time. From time to time areas of Crown Forest Land are taken up for such "gardens." Accessibility appears to be the principal criterion for selecting a piece of land.

The preparation of the "garden" is as follows : the trees are felled down the slopes and the land burnt to effect a speedy clearance with the minimum output of labour. Without any attempt at soil conservation the ground is planted with tannia, yam, &c., and crops are removed usually for two or three years only. The forest land thus destructively cleared to provide two years of scanty root crops is then allowed to go back into bush, and the peasant proceeds to seek out a new area. It may also be grazed when a "grassy" hillside results This system of "peasant gardens" in St. Lucia is exceedingly destructive. Not only is the practice of burning to effect an easy and rapid clearing wasteful of organic matter, but by the same procedure the steep hillsides thus exposed are alternately baked by the direct action of the sun and washed and eroded by heavy rain showers. Thus in the course of two years the peasant finds that even for his simple purposes his "garden" has degenerated to the point of abandonment. The area of forest land in St. Lucia which has been cleared in this way is already very considerable, and the position deserves careful attention. From the examination of such areas useful information regarding land deterioration and its recovery when supporting secondary vegetation was obtained.

### IV.—Virgin Forest Lands.

Considering the vast tracts of virgin forest lands which have been utilised for agriculture in the tropics, remarkably little information is available concerning their soils and the factors that make for fertility. Not all virgin soils are highly fertile but such fertility as they possess is undoubtedly destroyed by the continuous production of the same crop ([9]). It is, of course, easy to understand why an alluvial soil deposited in a broad valley by a silt-bearing river should be fertile. The production of good fertile soils on a mountainous volcanic island or on the steep foot-hills of a continental area is quite a different matter. Beginning with the original bare unpopulated surface material—the surface geology—a long series of plant colonisations and successions must have taken place to produce the present well developed rain-forest. Weathering of superficial volcanic materials takes place quickly, and analyses show that such materials are moderately supplied with the essential minerals in an available (*i.e.*, soluble) state ([2]). But such weathered material, although it becomes covered with a dense mat of vegetation, supports, from the botanical standpoint, plants which are not exacting in their requirements. The latter types make their appearance at a much later stage and only when soil conditions permit. In short, the final production of a highly fertile soil is the result of a long chain of biological processes.

Four different forest areas in the vicinity of the banana lands were inspected. Holes were dug at various points generally in line up or down the slope at right angles to the contours. The vegetation was of the rain-forest type and consisted of a considerable variety of comparatively tall trees, here and there covered with lianes, climbers and epiphytes, and with a scanty ground vegetation of ferns, Selaginellas, seedlings, and occasional bushes and palms. The amount of accumulated surface leaf mould was not observed to be great in any of the areas visited. In one area a series of the holes was dug at 10-20 yards apart, down a steep slope. A characteristic soil profile was as follows :—

1. Surface leaf mould—slight.
2. 12-18-24 inches of dark, loamy soil in good condition, with uniform texture and roots distributed downwards. The colour change from top to bottom was gradual. This layer gradually passed into,
3. weathered rock soil, with recognisable rock fragments.
4. Soft rock.

Profiles varied slightly from hole to hole but even on the steepest hillsides, a surface layer of good soil was the rule. In other areas of forest land near the crest of the ridge at least twenty inches of weathered soil, with the top four to six inches rich in organic matter was found. The hilltop soils, as one might expect, are not so good as those lower down.

It was consistently observed that the physical state of these virgin forest soils was undeniably good, the soil being sufficiently free to allow of easy root development. These soils compare very favourably with those of abandoned banana lands and peasant "gardens" where a sticky clay-like soil, poor in organic matter, overlies the partially weathered volcanic rock below, or passes into an intractable yellow clay subsoil. In other words the original fertile forest soil, has been destroyed by the cropping system or removed by erosion leaving behind soil materials which are less weathered, poorer in organic matter and separated by only a few inches from the unweathered rock below.

### V.—Reasons for fertility of Virgin Soils.

A comparative inspection of virgin forest land, and land which has been used or abused for extensive agriculture leaves little doubt as to the superior fertility of the former. The reasons for this might be briefly summarised as follows :

1. The untouched forest areas are profoundly influenced by the long accumulation and reactions of organic matter. By this one does not infer that the tropical forest floor is covered with a deep layer of vegetable mould. Indeed this is, in the tropics, far from being the rule. Thus Warming ([11]) observes : "The soil of rain forest is always a rich humus, black and porous, filled with mouldering remains of trunks, twigs, leaves, flowers and fruits, and presumably excavated by subterranean animals. Yet the layer of humus is not so thick as is often assumed ; layers several metres in thickness are not usual." A relatively scanty deposit of superficial mould was observed by the writer to be the rule in Central American forests as well as in St. Lucia. The formation of a deep layer of good soil has been achieved by the addition of organic matter over a long period of time, coupled with the absorption of this material into the soil by the activity of micro-organisms. The humid forest conditions and high temperature under which the breaking down of plant remains takes place are probably as important as the nature of the materials available.

2. Well established forests represent areas of land where long continued weathering, by sub-aerial agencies and the root activity of large trees has produced (in the case of St. Lucia) a superficial stratum of modified rock material. By weathering and root activity, together with the action of organic matter, the soil is gradually built up and ameliorated. Under forest conditions it is constantly maintained in a humid state, it is protected by the overhead canopy from the packing action of rainstorms, while its loose texture allows of the rapid downward percolation of water. Weathering of the superficial rock materials depends largely on the exposure of the hillside. By visiting different areas the writer found that the soft volcanic rock showed great differences in the depth to which it had been modified. This has many important

corollaries. Thus the influence of the forest mould depends to a great extent on the texture of the soil and its capacity for absorbing organic matter. For example it was observed in Panama that some stiff yellow clay soils, supporting giant forest trees, have apparently little capacity for absorbing organic matter, and that the layer of dark surface soil was inextensive, amounting in all to perhaps three or four inches. In such cases there is usually a sharp line of demarcation between the modified surface soil, rich in organic matter, and the unweathered yellow clay below. In contrast to this, where weathering goes on apace, the soil, or soft rock (as in St. Lucia) is deeply modified and brought into an open crumbling condition highly suitable for the absorption of plant remains. Thus the fate of surface organic matter is largely dependent on the nature of weathering, and the capacity of the soil to respond.

3. In St. Lucia, apart from the production of a fertile soil, one of the main reasons for the great difference between virgin land and abandoned areas lies in the fact that the forest soil, once it is formed, is kept in position, even on steep hillsides, and is not subjected to the violent erosion which has proved so destructive on exposed areas. The forest lands, cleared for banana cultivation and peasant "gardens" alike suffer from extensive erosion, which quickly removes all the rich loose surface soil, leaving behind the less friable, poorer underlying layers.

4. Virgin forest soil also owes much to the fact that it is the site of long continued undisturbed biological activities. That is to say it has gone through countless cycles in which essential minerals have been brought up from lower levels by root activity, assembled into the tissues of growing plants and finally returned to the soil surface by leaf-fall and the decay of trunks, twigs, flowers and fruits. It is unnecessary at this point to dwell at length on the important changes brought about by the fungal and bacterial floras of the soil. This continuous cycle of bringing up and returning, together with the factors mentioned above, is largely responsible for the homogeneous layer of good soil characteristic of the best forest areas. In dealing with biological activities the nature of the forest vegetation as a source of organic matter should be considered, and also the capacity of root-systems for penetrating and opening the soil. There can be no doubt that the type of vegetation is important in effecting soil amelioration. It will be shown below that many members of the secondary weed population do not make for speedy soil improvement. In fact the position is analogous to that of leaving fallow land under weeds or under a suitable cover crop.

Where hillside virgin soils are less good, other things being equal, some insight into the problem can generally be obtained by reference to the foregoing factors. In alluvial virgin soils, on the other hand, defects in fertility are generally referable to their closely packed condition or to adverse water relationships.

### VI.—Regeneration of deteriorated soils under natural conditions.

The abandoned banana lands together with the numerous areas opened for "peasant gardens" represent in St. Lucia a very considerable area of what was originally relatively good forest land. In its present state, deprived of the original surface soil and overgrown with a poor class of secondary vegetation it is practically worthless for agricultural purposes. As good land represents the potential future wealth of an agricultural island two questions naturally arise from the foregoing observations:—

1.—Is such deteriorated land capable of speedy regeneration by natural means? and
2.—What period of time will be required to regain a state of fertility comparable to that observed in the present virgin lands?

The first question is essentially one of plant ecology. It has been seen that when the banana lands of the rain-forest region were abandoned a secondary flora, entirely different from the original virgin forest, quickly encroached on the planted area. From the botanical standpoint this secondary flora flourishes because it consists of plants which are characteristic of waste places and inexacting in their requirements. The weed flora which has invaded the plantations to the detriment of the banana consists of species many of which are the first to populate slightly weathered rock surfaces, land-slide areas, and highly eroded open hillsides. Thus the rock faces exposed by the deep road cuttings in St. Lucia, are, in the humid inland regions, populated mainly by species of ferns. The latter therefore rank (given the necessary humidity) among the first colonisers of land where a true soil stratum has not been created. On this subject Treub [6] observed that three years after the eruption of Krakatau, when a new land surface had been formed as the result of volcanic activities, the new flora consisted almost entirely of ferns. The prevalence of *Cyathea* and other fern species in the abandoned banana areas in St. Lucia may be taken as an indication of the fact that most of the true soil has been either displaced or otherwise destroyed, leaving as the new surface materials not greatly removed from the underlying parent volcanic rock. The deforestated land does not revert to its original state but it is repopulated by a different flora.

The writer next made a series of observations to determine whether any marked improvement could be observed in soils which were supporting these characteristic secondary growths. For this purpose a number of peasant "gardens" abandoned for 10, 15, 25 or more years and repopulated by secondary vegetation were examined. The criteria employed were depth, texture, and colour of soil. One well grown

secondary forest, at least 20 years old, had a dominant tree population of *Cecropia* (80 feet high or more), occasional other trees, large clumps of *Heliconia* (Balisier or Wild banana) well grown bamboo clumps, *Miconia* bushes of considerable height, and a moderate ground vegetation of seedlings, ferns, &c. The overhead canopy was sufficient to keep down a rampant ground vegetation. Presumably some 20 or more years ago this steep hillside area had been washed bare of the original surface mould, leaving the underlying yellow clay exposed. On examination, from area to area, the soil profiles were not indicative of high fertility. A typical section showed five inches of dark top soil, rich with incorporated organic matter, overlying the characteristic yellow clay rock-soil. The weathered rock was much nearer the surface than it was ever observed in primary forest areas. Roots were not deeply penetrating and ran horizontally rather than vertically into the soil—partly a matter of anchorage and partly of nutrition. Higher up the same hillside an area of virgin forest was examined. Not only was the plant population more numerous and varied, but the soil was freely weathered out to a depth of 20 to 24 inches, the top 12 inches of soil being enriched with organic matter, with a gradual colour transition from top to bottom. On another peasant "garden" abandoned for 15 years, a certain amount of cattle grazing had taken place. The vegetation consisted of a ground mat of poor grass and low herbage, with occasional remainder clumps of Tannia, and here and there a few *Cecropias*, *Cyatheas*, clumps of *Heliconia*, and thickets of *Miconia* and *Psidium* (Guava). The larger plants, tree ferns, trumpet trees, &c., were scanty, and the impression from a distance was of a grass hillside punctuated by occasional trees and bushes. Soil profiles under (1) "grass" (2) a *Heliconia* clump and (3) a *Miconia* thicket, were examined.

(1) "*Grass.*"—This low herbage, frequently grazed, not only supplies little organic matter to the soil below, but it is so close as to smother any other seedlings which might have a regenerating action. The mixture of small grasses and herbs was found to be supported by a poor sticky top-soil 3 to 5 inches deep, only slightly darkened by organic matter and weathering, being the whole depth occupied by the thin root systems. Below this came immediately the sticky mottled sub-soil into which few roots had penetrated. In the absence of more deeply-rooting plants, weathering and soil amelioration are greatly slowed down.

Two other grass-grown areas in different localities were also examined. There again 3 to 4 inches of yellow-brown top-soil, filled with the thin roots of grasses and small herbs, passed downwards into a sticky yellow mottled sub-soil. There can be little doubt that such "grassy" hillside vegetation not only fails to effect soil improvement, but its close matted growth prevents the establishment of possible ameliorating species. Confirmation of this opinion, comes from Shantz and Marbut ([5]) who remark *à propos* of the grass grown soils of Tropical Africa, "While from the point of view of soil character, all of this immense area (the Tropical Belt) must be considered potential forest land, yet large sections consist either of pure grass land or of very open forest with a heavy cover of grass beneath the trees. Very little information is available as to the effect on the colour of the soil of this grass cover, but what information is available shows that it has not resulted in the production of a black or even a very dark brown soil such as has been produced on the treeless humid soils of the United States and apparently of parts of Argentina."

(2) *Heliconia Clump.*—Below the *Heliconia* clump a soil profile showed a definite layer of four inches of good soil, black in colour due to incorporated organic matter, crumbling, full of roots and of fibery texture, passing into the characteristic mottled sub-soil as before. This soil, although only a few feet away from (1) was noticeably more dry and friable. The well known ameliorating effect of *Heliconia* was thus amply borne out by direct contrast with the adjacent "grassy" area.

(3) *Miconia Thicket.*—The soil under a *Miconia* thicket was definitel better than that under grass, but it still compared very unfavourably with soil in the vicinity of the *Heliconia* clump.

From this brief comparative inspection, then, we may infer that the amelioration of such deteriorated hillside soils will depend on (*a*) the establishment of a suitable flora which will provide adequate supplies of organic matter, will draw off the excess of soil moisture, and by strong root action will aid in the processes of soil and rock weathering. The foregoing evidence indicates that *Heliconia* not only performs these functions but in addition by virtue of its growth into large clumps, serves also to catch and anchor drift and washed soil materials. On this subject with regard to Norwegian soils, Glömme ([3]) has ascertained that there is a very strongly marked connection between the state of the humus and the constitution of the forest growth and of the ground vegetation. While this connection is partly due to the fact that soil condition to some extent determines the kind of plant that will occur, Glömme regards the influence of the plants on the formation of the humus as being of greater importance. His observations refer of course to forests of the temperate zone, but while tropical conditions differ in degree and in kind the fundamental principle will probably be found to hold good. In order to produce the greatest soil amelioration a type of secondary vegetation should be established, which under the conditions prevailing, catches and anchors the soil, achieves root-tillage and yields the best type of organic matter.

### VII.—Concluding observations.

A general conclusion which may be drawn from these several botanical and soil inspections is that the secondary vegetation which has been established on the abandoned areas is one which is not readily displaced from its hold on the land. Even secondary forests some 25 years old show only a few additions of the original flora. Whether marked changes and new plant successions will quickly appear when a dense overhead canopy has been achieved remains to be seen.

From the practical standpoint one fact has definitely been ascertained, namely, that the regeneration of deteriorated land by the natural secondary flora is very slow and it is doubtful, if, even at the end of several decades, anything comparable to the original forest soil will have been attained. In the event of any agricultural project comparable to, but it is to be hoped more successful than, the banana industry being undertaken, the remaining virgin forest areas represent the raw material of the industry. Conservation of the soil fertility of these areas then should be a fundamental policy. Where a population is relatively small the available land appears to be unlimited. But this is not so. Already in St. Lucia large areas of relatively good forest land have been devastated and their soils degraded for the sake of producing scanty crops of ground provisions for two or three years. The interest that has been aroused in Jamaica ([4]) regarding the re-afforestation and conservation of soils, and the data accumulated with reference to the treatment of steep hillside areas, and river banks, and the introduction of new systems of cropping and use of afforestation materials, not only merit careful consideration but also provide a lead that might profitably be followed in many tropical areas.

In this article a land problem has been dealt with from the standpoint of a botanist rather than that of the practical agriculturist. The recognition of conditions, however, is invariably of importance and the judicious application of botanical knowledge to local problems of fertility has many useful results. The absence of such a survey may lead, as it has so often done in the past, to grave losses. Virgin forest land may be regarded as the raw material of the agricultural pioneer in the tropics. Before it can be exploited to advantage, however, its value must be truly assessed, otherwise the exploiter may find himself bankrupt while posterity is left with an infinitely poorer heritage.

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## NIGERIAN COCOA.

IT is reported* that the average quality of the 1928-9 Nigerian cocoa crop will be higher than it has ever been before, not only owing to the nature of the season, but also to a great extent to the influence of the produce inspection scheme. The effect of enforcing a high standard in the quality of cocoa as regards freedom from mouldy beans, and dryness, has now reached back through the various grades of buyers to the producer. Thus, except in regard to the small quantity of cocoa harvested "out of season," (which is almost inevitably inferior) practically the whole crop is now properly dried immediately after harvesting on the farms, and a really bad parcel of cocoa is a rare sight. This is a very great contrast to the state of affairs a few years ago when a good parcel was an exception. In the current season the produce inspectors are, for the first time, regularly grading cocoa in two grades according to the content of fermented beans. At present the position in regard to fermentation is the same as it was three years ago in regard to freedom from mouldy beans—really well-fermented cocoa is quite exceptional. It is hardly to be expected that improvement in fermentation can be effected as quickly as was the improvement in "purity" and drying. However, the efforts of the Agricultural Department in demonstrating the technique of fermentation, and the higher prices paid by some firms for fermented cocoa during the last few years has already had a definite effect in increasing the care generally taken in fermentation and there is every reason to hope that the change now introduced into the produce inspection system will effect the desired improvement in the course of time. At present cocoa reaches the high standard demanded in the first grade, and as the trade has not fully realised how high that standard is, it is as yet hardly fetching the price that it is worth.

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* 1928 Colonial Report, Nigeria, No. 1435.

# SUGAR-CANE MOTH BORERS.

## Some recent work on parasites of the small moth borers (*Diatraea*) of sugar-cane.

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OF all the insect pests of sugar-cane the small moth-borers (species of *Diatraea*) are probably the most widely distributed and the most generally injurious. This is decidedly the case in the tropics of the New World, where recent research, on more intensive lines than in the past, tends to emphasise their importance. Some of the most thorough of these investigations have been carried out by the entomologists of the Tropical Plant Research Foundation in Cuba; and there it appears that the injury inflicted by *Diatraea* is increasing year by year. This may quite well also be the case in the British colonies, although in some of them such as British Guiana the usual infestation is so much higher than that hitherto reported for Cuba that there are grounds for the view that it has reached a maximum for the present agricultural and biological conditions. Whether or not this is the case, it is not certain that the considerable work already accomplished on *Diatraea* has in any case produced any appreciable measure of control. It is apparent that far more fundamental investigations are required—intensive and co-ordinated and on a scale commensurate with the magnitude of the industry concerned.

There are two promising lines along which such research might proceed. The first consists in a thorough ecological study such as *Diatraea* has hitherto nowhere received. This is essential if *Diatraea* is to be regarded as a problem to be solved once and for all, rather than as a permanent nuisance to be mitigated by mere *ad hoc* partial methods.

There is one sugar-cane pest, the froghopper (*Tomaspis Saccharina*) in Trinidad, of which the physical and chemical ecology has been really thoroughly studied, with extremely valuable results. Similar data are urgently required for *Diatraea* and exact numerical observations also on the processes involved in the growing of cane and rice from the point of view of their effect on *Diatraea* and its parasites. Such a study should strenuously avoid mere expressions of opinion, and should base its results on exact quantitative studies of borer infestation and of rate of parasitism at various stages in the growth of the crop. Much has been written on the bad effect the burning of fields before cutting is said to exert on the parasites, especially the egg-parasites. This depends largely on the rate of effective parasitism; and no statement made on our present knowledge can be much more than a pious opinion.

Many estates both in British Guiana and in Trinidad, regularly employ large gangs to collect borers from young cane. In most cases the resulting catch is counted and straightway destroyed. The effect of this practice on the parasite balance has never been investigated in the British Colonies, nor has its real effect on the infestation been ascertained. Recently, by carefully controlled experiments in Cuba, Plank has shown that cutting out of "dead hearts" greatly reduced the percentage of borer parasitism, "and at harvest time it was over 20 per cent. less in the fields from which the dead hearts had been removed than in the adjacent untreated fields." This result of course, needs confirmation in other colonies, but as it stands it gives cause for much thought.

Then again there is the question of weed-grasses. Many of these harbour the borer, but in many, if not all, the rate of parasitism is higher than it is in the cane. Several species of parasites which do not attack the borer in cane, parasitise it in these grasses, the flowers of which, in many cases, are moreover greatly attractive to the adult parasites. This example is given to show the extreme complexity of the problem and the need for studying *Diatraea* not only in the two main crops (cane and rice) which it attacks, but in its wild hosts and original habitats too. So far as the British colonies are concerned such work could well be centred in British Guiana and in Barbados, as representing the two ecological extremes of this region. It is essentially a task for whole-time resident entomologists.

The second promising line of work lies in the direct utilisation of parasites. The needs here are threefold:—firstly to work out in detail the complex interrelations of *Diatraea*—plant-host—parasite, outlined above and to study the effect of the agricultural operations on this balance; secondly to devise ways and means of assisting artificially the parasites already present; and thirdly to introduce new parasites. The first and second again fall within the province of the resident research entomologist suggested above. It is with the second and third that I am chiefly concerned here.

In the encouragement of local parasites it is rigidly-controlled experiment on a large scale which is needed. It must be emphasised that while the introduction of foreign parasites is a recognised method of biological control, with many overwhelming successes to its credit, the attempted encouragement of indigenous parasites has nowhere been unequivocally successful. The rearing and liberation of native egg-parasites (chiefly *Trichogramma*) on a very large scale is a new development, the application of which is being watched with the greatest interest. Without digressing far into the history of this innovation, we may gather from a collection of recent papers some notion of its progress.

It was Cleare in 1921 who first devised a method for breeding on a large scale the egg-parasites (*Trichogramma* and *Prophanurus*) of *Diatraea*. This method, which is still practised on three or four large estates in British Guiana, most ingeniously utilises the material brought in by

the borer gang which most estates in that Colony employ to cut out borer-infested shoots ("dead hearts"). These shoots are stored in the insectary and the moths which emerge produce the eggs which are used to rear *Trichogrammas* for liberation. By this means from one insectary as many as 35,000 egg-parasites have been liberated per day for three months at a time. On the estate where the present writer has recently had an opportunity of studying it in detail an average of 6,000 per day were liberated during 1928.

In California, Flanders desired to utilise *Trichogramma* against the codlin-moth (*Cydia pomonella*). This insect being notoriously hard to rear, it was necessary to find some other host upon which the egg-parasites could be bred in sufficiently large numbers under laboratory conditions, for liberation early in the season. To Flanders belongs the threefold credit of recognising this difficulty and meeting it adequately; of realising the prodigious numbers of parasites which must be liberated if this method is to enjoy any prospect of success; and finally of elaborating a method by which such numbers could be produced with a minimum of labour, time and expense. The essence of Flander's scheme lies in the utilisation of the Angoumois grain moth (*Sitotroga cerealella*) as the laboratory host; and it is sufficient tribute to his ingenuity that later workers have followed his methods almost exactly.

Flanders has calculated that, to control a plant pest by means of *Trichogramma* thus reared, it is necessary to liberate 10,000 for every 100 square yards of leaf surface of the crop to be protected. At his own rearing plant he has aimed at a liberation of one million parasites per day.

The first to apply his methods to *Diatraea* were Hinds and Spencer in Louisiana, in 1927. They claimed certain practical results by liberating *Trichogramma* in large numbers earlier in the season than it normally occurs.

The most recent attempt to use *Trichogramma* against *Diatraea*, and the one which concerns us most here, is that of Tucker in Barbados. In Barbados I am assured by Professor Ballou that it is not the custom to employ borer gangs. There is no readily available supply of borers and the Angoumois grain moth is thus found to be the most convenient laboratory host. On estates where borer gangs are regularly employed, *e.g.*, in Trinidad and in British Guiana, there can be no doubt that the borers themselves are more conveniently utilised, at least for the numbers at present used. By this means on one estate in British Guiana, an average of 6,000 a day are reared by the labour, full time of one boy, and part time of a locally-trained man.

Tucker's scheme has already been described in this journal (Vol. VI, No. 8, July, 1929) and it is only necessary to state here that he is rearing about two million *Trichogramma* per month, and plans eventually to produce considerably more during periods believed to be critical. The parasites are being distributed to the planters in lots of 12,000 parasitised eggs made up of small paper slips each holding about 50 eggs. It is instructed that one paper should be deposited to every 10 stools of cane, in chessboard fashion. There would thus be 150 slips or 7,500 parasites per acre.

It is proposed to treat the whole island of Barbados; so that the experiment is on such a scale that very widespread interest will attach to the results.

It remains to raise a question as to the numbers of liberated parasites necessary for an appreciable measure of control. If Flander's estimate of the requirement is even remotely correct, it is obvious that not only the Barbados numbers, reared on *Sitotroga*, but also the British Guiana liberations bred on *Diatraea* and very much larger in proportion to the area served, are hopelessly inadequate. So far as *Diatraea* is concerned, data are available which permit us to view the problem from another angle. Throughout British Guiana *Diatraea* infests about 90 per cent. of the stalks of all cane grown, and about 25 per cent. of the joints (Cleare), and this in spite of the fact that *Trichogramma* parasitises the eggs at the rate of at least 35 per cent. (Cleare, 1928, estimates 40 per cent.). This suggests a point I have never seen raised in any discussion of the problem. As in the European corn-borer (*Pyrausta nubilalis*) so in *Diatraea* those influences which Thompson and Parker have aptly named "intrinsic controlling factors" are responsible for a very high mortality among the newly-hatched larvae before they have ever entered the cane-stalk at all. Cleare estimates this mortality at 90 per cent. and my own observations lead me to believe this an under-estimate. In other words the young larvae from at least 90 per cent. of the *Diatraea* eggs will die in any case, whether parasitised or not. This obviously very materially reduces the *effective* work of the egg-parasites, and in fact renders them no more important than the larval parasites. It goes far also to minimise the oft-quoted evil effects of burning the cane-fields before cutting.

It is possible on the above data and with certain theoretical assumptions to make various calculations as to the effective rate of parasitism of *Trichogramma* and as to the number required on a given area, with a given infestation, to raise that rate sufficiently to achieve control. Until, however, more intensive biological studies have been made, on the lines suggested above, I do not believe such calculations could be sufficiently accurate to guide practical work. What is urgently needed in the utilisation of egg-parasites, is a rearing and liberation of at least a million a day, and a concentration of this total on a *small* area where demonstrable, substantial and unequivocal results can be expected. Until then we are working in the dark.

While the first to utilise the *local* parasites of *Diatraea* on a large scale was Cleare, the pioneer of biological control by the introduction of *foreign*

parasites in the West Indies was Box, to whose enthusiasm much of the present local interest in this method is due. The success of such introductions must depend firstly on a thorough study of the *Diatraea* and its parasites in the various parts of its range; and secondly on a judicious selection of parasites to be introduced into regions where they do not naturally occur. In his paper of 1928, Box describes the habits and life-history of one of the most important of these West Indian parasites, the Tachinid fly, *Lixophaga diatraeae*. It is believed to be larviparous, but this and many other details of the life-history are at present unknown. The known natural range of this fly includes the Greater Antilles except Jamaica. It has been introduced since 1915, into Louisiana, Mexico and British Guiana—apparently with very little success. Box suggests that in the case of all these countries the new conditions were too dissimilar to the original habitat, for speedy success to be achieved. This seems very reasonable as also is his further suggestion that *Lixophaga* be introduced into Barbados, where environment would be more like that of its home. The writer hopes, with the concurrence of the Barbadian authorities, to carry out this proposal during his present mission. Another suggestion of Box, may, in view of the proposed inter-island air service, prove a very fertile one, namely, the utilisation of aeroplanes for the rapid transport of parasites like the Tachinids which often suffer considerable mortality on long journeys.

The most recent and useful contributions to a survey of known parasites of *Diatraea* are the list by Box (1927) which includes only American species, and the well-documented catalogue by Van Dine which is world-inclusive. In the introduction to the latter Van Dine makes a plea which may fittingly conclude these notes. He writes: "Our interest in the subject is international. We hope that mutual interests in those countries where sugar-cane moth-borers are a problem will lead to closer co-operation in control by the use of parasites. While the writer favours co-operation in all efforts on explorational work for parasites, it is not considered that joint support and direction of such work is practical. Each region should assume its share of the work, directed to meet its own requirements, and by real co-operation profit by the work of all."

So far as the British colonies are concerned, a very considerable step towards such co-operation has been made by the appointment of the present reviewer to investigate under the auspices of the Empire Marketing Board, the biological control of *Diatraea* and other major pests throughout tropical America.

As a concrete item in such co-operation nothing could be better at the present stage than a uniform method of recording rates of borer infestation and parasitism. In British Guiana, where of the British colonies, *Diatraea* has been studied most intensively, it has long been the practice on many estates regularly to record at the time of cutting the percentage of stalks and the percentage of joints bored in every field. A collection of such records from the chief estates of all the British colonies would be of inestimable comparative value and would serve as a check on the effects of parasitic introduction.

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## CO-OPERATION AMONG PRODUCERS.

AN interesting letter written by Lord Melchett appeared recently in the *Times* where, after referring to the successes achieved by the Jamaica Banana Producers' Association, he states that Jamaica is not an isolated case, but a unit in a general movement throughout the Empire to bring about co-operative effort among producers. Of the many bodies already in existence it is very gratifying to note that he mentions the Trinidad Cocoa Producers' Association, which, he says, is a model of its type of organisation and which, like others, is a member of the British Empire Producers' Organisation. In conclusion he advocates a progressive and continuous Empire Economic policy on non-party lines by the British Government which, he hopes will take the matter up at the 1930 Imperial Conference.

## NIGERIAN COCOA EXPORTS.

THE actual cocoa exports from Nigeria in recent years have been as follows:—

| | | | *Tons.* |
|---|---|---|---|
| 1924-5 | .. | .. | 36,700 |
| 1925-6 | .. | .. | 38,200 |
| 1926-7 | .. | .. | 42,300 |
| 1927-8 | .. | .. | 43,000 |

# CINCHONA IN THE EMPIRE.

[*Published below are extracts of an article on "The progress and prospects of Cinchona cultivation in the Empire" which appeared in* Vol. VIII, No. 1 *of the Empire Forestry Journal, by J. M. Cowan,* M.A., D.SC., F.L.S., *late of the Indian Forest Service, Off. Director Botanical Survey of India and Superintendent of Cinchona Cultivation, Bengal.*]

## Introduction.

THERE is at present within the Empire a large proportion of the malarial tracts of the world and the direct losses sustained by the British Empire due to sickness and death caused by malaria are said to amount to between £52 and £62 million a year. The supply of quinine is, at present, essential in the combat of malaria and the source of quinine is cinchona. Mechanical measures can be taken to exterminate the *Anopheles*, but without the alkaloids furnished by cinchona bark for both therapeutic and prophylactic use, there is little hope of success in controlling malaria over large territories.

The combat of malaria is not only a national but an international problem, and the organisation of anti-malarial work has been undertaken by the League of Nations. The policy involves the quininisation of affected populations: hence the cultivation of cinchona for the production of quinine is a matter of first importance.

## Historical.

Prior to about 1880 the world's supply of cinchona bark was obtained from its native forests in Ecuador, Bolivia and Peru, but, when the export of bark from the South American forests could no longer be relied upon, attempts were made to grow cinchona elsewhere. The history of the introduction of cinchona into Java and India and its successful cultivation is well known. The adventures and hardships of the pioneers—Wendell, Hasskarl, Markham, Ledger and others, who, by their efforts established for mankind secure supplies of this important drug, have been recorded elsewhere.

In the early days of cultivation, experiments were made in various countries, in India, Burma, Ceylon, Malaya, the Sudan, St. Helena, Jamaica, Trinidad, Mauritius, Australia, and New Zealand, but they were not always pursued to a definite conclusion. In Ceylon and in India, efforts were successful, and showed that the plant could be grown commercially in both these regions.

Since then, however, the private planting of cinchona in Ceylon and India, as will be explained, has practically ceased and the position within the Empire with regard to the production of cinchona and quinine may be summarized as follows: India is the only country where cinchona is cultivated on a large scale. There are in India, Government cinchona plantations in the Nilghiris in the Madras Presidency, in the Darjeeling District of Bengal and another, more recently attempted, in Burma. There is also a quinine factory in both the Madras and Bengal provinces.

It is a well-known fact, however, that to grow cinchona on the same land for a considerable number of years is a difficult and hazardous undertaking, for the first crop, in some manner not altogether understood, renders the soil, at least temporarily, incapable of producing a satisfactory second crop. As long as there is an unrestricted area of forest land the above factor seems of little consequence, but it makes itself felt more and more as the years go on and there is an increasing shortage of land carrying virgin forest.

## Quinine Production in India and Java.

Cinchona was introduced into both India and Java between the years 1854 and 1864. In India the plantations on the Nilghiris were opened in 1861, and those in Bengal a few years later. Soon after this time, induced by the success of the Government ventures, many private planters, especially in South India and Ceylon, took up the cultivation of cinchona. By 1890 production was considerably in excess of the demand and prices consequently fell. No guarantee of a minimum rate for bark was forthcoming and as tea gardens were at that time being rapidly opened and showing good returns, much of the cinchona was uprooted, and tea, which is easier to cultivate and gives a more certain return, was planted in its stead. A return to cinchona planting has never been made by private planters, so that at the present time there a e in India practically no cinchona plantations other than those owned and managed by Government. Further, much of the land which would have been suitable for cinchona is now under tea.

Turning to Java, it was not until 1910-11 that a similar problem had to be faced there. Conferences were called and manufacturers in Holland and growers in Java came to an agreement by which profits were to be shared and by which prices could be maintained at a level, which would show satisfactory returns. That disaster to the cinchona plantations in Java was averted was largely due to the adoption of this policy, and certain supplies at least are now available for world-wide distribution.

Comparing production in India and Java, Java now produces well over 90 per cent. of the world's supply of cinchona bark and India only about four per cent. A very small percentage of the bark at present consumed comes from the forests in South America.

In the production of cinchona and quinine, India is the most forward and not the most backward of the countries within the Empire, but there is no doubt that within India itself the production of cinchona could be greatly increased both by extending the area under cultivation and by more intensive cultivation. It is not unlikely, too, that there are other places within the Empire where cinchona could be successfully grown. The cultivation of cinchona is now long past the experimental stage, the requirements of the different species are known, and a knowledge of

correct methods of tending has been acquired. There is a considerable literature on the subject and more important valuable practical experience.

### Species of Cinchona.

Of the 65 species of the genus *Cinchona* of the Index Kewensis only three bear a sufficient percentage of alkaloid to be worth cultivating—*Cinchona Ledgeriana* Moen, *C. succirubra* Pav., and *C. officinalis* Linn.

These species contain in their bark varying percentages of quinine and the other alkaloids, cinchonine, quinidine, cinchonidine and quinoidine. Quinine is the only one of these which happens to be mentioned in the British Pharmacopoea, but it is the trend of modern medical opinion that the others, especially cinchonidine, or a mixture of all the alkaloids, are at least as efficacious as quinine.

The percentage of alkaloids in the bark varies not only with the species but with the individual tree, with the locality, age and portion of the tree from which the bark is taken. On an average, however, the yield from the various species in India is approximately in the following proportions :—

| | *Quinine.* | *Other alkaloids.* | *Total alkaloids.* |
|---|---|---|---|
| *C. Ledgeriana* .. | 5.49 | 3.03 | 8.52 |
| *C. officinalis* .. | 2.93 | 2.07 | 5.00 |
| *C. succiruba* .. | 1.40 | 4.85 | 6.25 |

It will be seen, therefore, that whether quinine alone or the highest total alkaloid percentage is required, *Cinchona Ledgeriana* is the species to be preferred, and this species is in fact, although the reverse is sometimes supposed, no more difficult to cultivate than the others. The principal difference is that *C. officinalis* will grow at slightly higher and *C. succiruba* at slightly lower elevations. All three species are fastidious in their requirements.

### Necessary Factors for successful Growth.

The ecological factors necessary for the successful growth of *Cinchona Ledgeriana*, so as to yield a satisfactory return of bark and alkaloid, may be summarised as follows. In India it has been found that suitable conditions are only present where there is evergreen forest on granitic or volcanic rock formations. The soil must be rich, porous, well-drained and with moderate to steep slopes. The least water-logging is fatal to the plants.

As to climate, *Cinchona Ledgeriana* will stand neither great heat nor frost ; the ideal temperature may be taken as about 75°F. with a mean minimum of 60°F. and a mean maximum of about 85°F. A hot sun with no shade is unfavourable. The limits of rainfall are roughly from 75 to 180 inches per annum. Even 200 inches may not be excessive on a well-drained soil, but a much lower rainfall on a stiff clay would prove disastrous. The upper limit in altitude is about 5,000 feet and the lower limit about 1,500 or 1,000 feet. Cinchona grown at low elevations usually has, however, a poor percentage of alkaloids. Although the above particulars indicate the type of land that may be suitable for cinchona, it must be remembered that, even in a locality where all conditions appear to be favourable, it is advisable to plant experimentally before attempting operations on a large scale.

### Methods of Cultivation.

The sequence of operations in India is as follows. In preparing a site for cinchona, the forest is felled during the cold season—from November to March—and the debris is burned in March. The land, if steep, is usually terraced and is then staked to mark the future position of the cinchona trees, four feet by four feet being the spacing usually adopted.

Before planting out, seedlings have been in the nursery for at least six months The seed, which is extremely light, one ounce giving some 20,000 plants, is sown usually in March. Seedlings are twice transplanted, first when the seed leaves are just fully expanded, at a spacing of one inch by one inch, and later, at the age of three to four months, in May or June, when the seedlings are two or three inches high and then at a spacing of three inches by three inches. The soil for the nursery beds has to be carefully prepared. It is mixed with finely-sifted leaf mould collected in the forest and worked by hand to a fine consistency. The nursery beds are sheltered by a sloping roof of thatch, which must be perfectly watertight and the plants must be carefully watered with a fine spray.

Some fourteen days before the plants are to be put out the roofing of thatch is gradually removed so as to accustom the plants to open conditions.

Planting begins in May in specially prepared "tullies" or pits which are dug at each stake to a depth of 18 inches and with a diameter of one foot. Planting in Bengal can be continued with favourable weather until August, although it is preferable to finish earlier. In Darjeeling no shade trees are planted, but these are necessary in Madras and Burma.

For the first two or three years the young plantation must be cleared two or three times per year and later once a year. The first year after planting a heavy hoeing is necessary. Later, periodical hoeing round the trees is all that is required.

Harvesting of the bark begins in a block from about the fourth year. Before this age there is as a rule very little bark and very little quinine in it. The harvest at the fourth year consists of the bark from thinnings and prunings as far as they are necessary, but mainly from plants which die. The final uprooting of a block is made about the tenth year. Figures available show that, although many trees will live longer than ten years, the rotation which gives the greatest return in quinine per unit of area is about eight or ten years, according to the rate of growth of bark, the percentage of quinine in the bark at varying ages and the number of casualties.

At the final harvest the whole tree is as a rule uprooted and the bark stripped from root, stem and branch, a method which probably gives a larger yield per unit of area than a system of coppicing, which has also been tried. The bark is dried, stored and then passed on to the factory.

Although the particular conditions demanded by the cinchona species render their profitable cultivation possible only in certain specialised localities, there is little doubt that such areas can be found. The failure of early experiments may be no criterion of the suitability of certain localities, for practical experience has improved technique. There are untried areas in India, Malaya, Tanganyika and elsewhere where conditions would seem to suit, and there may be other countries where land may be available and conditions not unsatisfactory.

### The future prospects of Quinine production.

To increase production the immediate problems which have to be faced are first, to find more suitable land, and second, to enhance the output per unit of area.

The problem of finding suitable land resolves itself into a process of elimination. The data that have been given will at least serve to eliminate many areas as totally unsuited. Having found localities which seem to furnish the particular requirements, the next step is to plant experimentally. A sample plot of from one to ten acres, properly tended, will, in at most four years and possibly in less, serve to indicate the quality of the locality. Such an experimental survey would obviously have to be carried out under Government auspices.

The second problem is mainly a matter of research, and the need for such research in connection with existing plantations has been pointed out by the Royal Commission on Agriculture in India in their recent report. On page 491 of their report the following statement is made:—"If India is to embark on any large campaign for fighting malaria, we are convinced that it will first be necessary to reduce considerably the price of quinine within India, and this can only be effected if India is self-supporting in production. To achieve this self-sufficiency a considerable extension of the present area under cinchona will be required . . . We are of opinion that a research institute for the investigation of cultural difficulties met with in growing cinchona is desirable. We are, however, satisfied that, in view of the great importance of extending cinchona cultivation and cheapening quinine, much more scientific investigation is called for than has been undertaken in the past."

There is a great deal of scope for investigation with regard to particular strains which yield high percentages of quinine and little methodical selection has yet been undertaken. The highest percentage obtainable has certainly not yet been reached, and it must be remembered that an increase of one per cent. in quinine content is equivalent to an increase of about 20 per cent. in true production. The difficulty of rearing subsequent crops on one piece of land which has already borne cinchona has been referred to. It has been partially solved by planting a forest crop as soon as the cinchona is uprooted. Fallowing in forest for 15 to 20 years with an uncertain crop to follow is not altogether adequate and probably needlessly wasteful. In Java, for example, it has been found that scions of *C. Ledgeriana* grafted upon *C. succirubra* stock permit of re-planting successfully at a shorter interval. There is here, then another problem which assumes greater and greater importance, as land suitable for cinchona becomes restricted by development in other directions. Again, to obtain the maximum yield from a given area a definite preconsidered planting and harvesting programme is necessary. The maintenance of the yield over a period, especially where operations are complicated by the necessity for fallowing the land, is dependent upon a definite working scheme and the best results cannot be expected if the development of cinchona is made subservient to unstable political or financial considerations. As long, however, as quinine remains the principal agent in the combat of malaria, the increased production of cinchona is one of the first steps to be taken towards the subjugation of the malaria parasite.

## COTTON IN EGYPT.

The discovery of the high yielding Ashmouni types has given very considerable impetus to the cotton cultivation of Upper Egypt. News is to hand that an excellent long staple cotton, very little inferior to the Domains staple cotton has been grown in several places in the region south of Assiut, a section which, until recently, was regarded as being outside the cotton-growing area. The fibre gave 34 mm. halo length, 36 mm. staple pull, and a yield in all the trial fields as high as the best Ashmouni in the surrounding area. It is anticipated that there will be 500 feddans this year of this variety, 5,000 next year, and 50,000 in 1931. When the limitation of the Cotton Acreage Act has expired, there is bound to be a huge increase in the supply of very high-class cotton through the enormous development which has taken place in Upper Egypt, and the author prophesies that Egypt will very shortly vanquish the long-staple production of United States of America.—(*The Journal of the Textile Institute*, Vol. XX, No. 5.)

## RUBBER LATEX TRANSPORTATION.

A new type of vessel has been designed by the Aktiebotaget Svenska Ostasistiska Kompaniel of Gotenburg according to a report from the Department of Commerce. The ship is fitted with specially built tanks, electrically heated, so as to carry latex or coconut oil in bulk to any climate in exactly the same temperature and condition as when loaded.—(*Industrial and Engineering Chemistry, News Edition*, Vol. VII, No. 16.)

## HIGHER SEA ISLAND YIELDS.

[*In this article which is reproduced from the "Commercial," Vol. XIX, No. 480, Mr. John A. Todd the well known world's cotton Statistician and the Principal of the City School of Commerce, Liverpool, discusses the prospects of the Sea Island Cotton Industry in the West Indies.*]

For several reasons there has recently been a slight but definite revival of interest in Sea Island Cotton, which for the past 10 years has been suffering from a period of almost complete stagnation. Before the war the Sea Island supply consisted of nearly 100,000 bales from the "islands" of South Carolina and from Florida and Georgia, with a small additional supply of about 7,500 bales from the West Indies; but the arrival of the boll weevil in the Atlantic States about 1918-9 wiped out the American supply with catastrophic completeness and rapidity, which was due partly to the recognised hopelessness of trying to fight the weevil with long-staple late-maturing cotton and partly also to the peculiar conditions of the war years, when luxury fabrics of the kind made from Sea Island cotton were almost unsaleable.

Thus the American supply disappeared almost without a struggle, and the most astonishing feature of the whole business was that nobody seemed to miss it. The special sections of the trade which had formerly been dependent on Sea Island turned over apparently without difficulty to Egyptian cotton, especially Sakel, and Sea Island became a small isolated section of the cotton trade in which the cotton world as a whole took no interest. The situation was made all the more difficult for the growers of the small remaining supply in the West Indies by the fact that comparatively large stocks remained after the war. These were only slowly exhausted, for the post-war boom again left Sea Island rather out of the rush, and when the deflation slump set in about 1921 Sea Island once more felt the worst of the depression. There was, quite naturally, a strong agitation from high quarters to reduce the already diminished supply still further by restricting the acreage; and altogether the state of affairs in the Sea Island section was just about the very worst in the whole cotton trade. When the huge American crop of 1926 sent cotton prices down below pre-war levels, the effect on Sea Island was once more to produce a piling up of stocks, and the arguments for restriction were renewed, though with only partial success.

The causes of the present recovery are to be found on the side both of supply and demand. In the first place great efforts have been made in recent years to revive the use of lace, which is now almost the only form of ladies' clothing in which Sea Island cotton has much chance. Efforts have also been made, especially in America, to revive the demand for cotton styles, and to push the sales of the fine cotton fabrics which had been hard hit by the use of silk, both real and artificial.

As it happened, the supply was in a position to respond very quickly to the slight improvement in the demand. In spite of what reduction there may have been in the acreage, the West Indian crop was holding steadily at its post-war figure of about 5,000 bales, and mainly for one interesting reason. Many of the islands were finding it possible to increase their average yield per acre by various methods, partly by the introduction of new and heavier-yielding varieties, partly by the adoption of different seasons of the year for the crop, and partly because the measures adopted to control the pink bollworm seemed to be meeting with substantial success.

It is one of the peculiarities of the West Indies that conditions vary from one island to another almost immediately adjoining, like St. Kitts and Nevis. In these two islands, which are virtually twins separated only by about a couple of miles of sea, the whole conditions of the cotton crop vary—the varieties planted, the time of planting, the yield per acre, and, above all, the position of cotton in the agricultural system. In Nevis, as in Montserrat, cotton is the main crop, grown for its own sake and forming the chief source of the planters' revenue. In St. Kitts, on the other hand, cotton is merely a catch crop thrown in, as it were, to take advantage of a brief gap in the sugar year, when the land can be spared temporarily for another crop. The time of the year at which this gap occurs is admittedly not the best for cotton, and the result is that the yield per acre is substantially less than in the other Leeward Islands.

It is this change in yield per acre which is the striking and the most interesting development of the position. The writer has just seen in Montserrat fields of cotton in which most of the plants carried more bolls on one branch than an ordinary field in Texas would show on the whole plant. A yield as high as 300 pounds an acre is nothing extraordinary; much higher figures are quite well known, and the average for the whole island last year was 231 pounds an acre. Nevis this year has substantially exceeded even that figure, because there, for the first time since pink bollworm appeared, they were able to let the cotton remain long enough in the ground to get a second picking. None of the other islands has yet been able to do so, because of the close season which has been enforced everywhere as one of the means of controlling the pest. There is no doubt, therefore, that the whole position of the producers has been changed by this new factor of a heavier yield and the quality of the cotton has not suffered in the process, for the Montserrat cotton is of excellent staple—not quite so long or superfine as the very high fancy types of St. Vincent cotton, but a really excellent "bread and butter" Sea Island which is welcome to those fine spinners who want a little of something better even than the best of Sakel.

All this raises a most interesting question as to the future possibilities of these developments. There is no doubt that the recent recovery of

demand has been very satisfactory to the growers, not only because prices were better but still more because there was no longer the heart-breaking delay of sometimes a year or more in getting their crop sold at all. There is perhaps some danger that this may lead to an unduly rapid return to the original acreage or an even larger one, and thus produce an over-supply once more, for it must be remembered that cotton in the West Indies is essentially an alternative crop, always competing with sugar. It is very largely a question of the relative prices of sugar and cotton. It was when sugar failed the West Indies so lamentably at the end of the last century that cotton was introduced to save the situation, but when the war cut off Continental supplies of beet sugar, and cane sugar came into its own again, cotton was quickly left in the lurch.

Now sugar looks like falling again, and it is a difficult question whether the failure is likely to be so severe or so lasting as to tempt planters back to cotton again. Barbados, which has almost dropped cotton, is seriously thinking of taking it up again, while St. Vincent, which has shown marked reduction in its cotton crop of recent years, may once again come back to its leading position. But the position in St. Kitts is perhaps the most interesting of all. There sugar is everything and cotton is only incidental. The whole organisation of the large estates is designed for sugar, the capital expenditure for that crop has been very great, and it would be a serious business to scrap all that and go for cotton instead; but it could be done, if it would pay, and the St. Kitts cotton is of very high quality.

Thus the whole question becomes an argument in a circle. More Sea Island cotton can be produced if the world wants it and is prepared to pay a price which will reasonably cover the cost of production, which is necessarily high on account of the great care that Sea Island cotton requires in its growth and its handling, as well as on account of its comparatively low yield. The figures quoted above are, of course, better than those of the old days, but they are not high compared with Egyptian, and they are not to be taken as general averages. A bad year, either in the weather or in the damage done by the pink bollworm, may reduce them lamentably, while a hurricane—and there have been two in four years at Montserrat—may entirely destroy the crop, though here again the change of season is important, for under the new regime the crop may be almost over before the hurricane season opens.

Nevertheless, under the new conditions it seems quite clear that at present prices the position of the grower, whether peasant, farmer, or large owner, is sufficiently satisfactory to make an increased crop probable. Will the recent recovery of the demand prove sufficient to take up the increased supply, and will the demand last? On that point, of course, no one can prophesy, but the signs are encouraging; it is of particular interest that certain potential buyers from the United States have recently been visiting the islands and making tentative offers. The situation will require to be watched carefully both by the producers and consumers, but it would certainly be very satisfactory if the recent revival should prove to be lasting.

## MYCOLOGICAL NOTES.

### Lime and Sugar-Cane diseases in the West Indies(1).

Mr. S. F. Ashby of the Imperial Bureau of Mycology, whose chief object during his recent visit to some of the West Indian Islands was to investigate Red Root disease of limes in Dominica, believes that of the fungi associated with the disease, viz.: *Sphaerostilbe repens* B. and Br., *Fusarium* sp., *Phomopsis* sp., *Botryodiplodia theobromae* Pat., &c., none are active parasites, but are saprophytes or weak to very weak parasites, whose presence is dependent on the enfeeblement of the host by adverse soil and climatic conditions. The July, 1926, storm which caused considerable injury to shallow rooted seedlings, and the protracted wet weather which followed, are specially mentioned as contributory factors. These views are in agreement with those expressed by Dr. Briton-Jones(2) who visited Dominica in July, 1927, and the latter's recommendation to bud lime on sour orange stocks as the only effective remedy is also supported.

Wither tip of limes, caused by the fungus *Gloeosporium limetticolum* Claus. is stated to be very serious in some localities in Dominica and St. Lucia, but is believed to be absent from Antigua and Montserrat.

In Antigua Mr. Ashby found that gumming disease (*Bacterium vascularum* G. Smith) of sugar-cane was very prevalent. A survey of the distribution of the disease on different cane varieties indicated that the widely cultivated variety Ba. 11569 was almost universally infected, chiefly in the leaves and leaf sheaths. Other varieties only showed slight infection when growing next to Ba. 11569 plants. Although during the previous cane harvest no trouble due to the presence of gum in the juice had been detected, Mr. Ashby convinced planters to substitute Ba. 11569 for more resistant varieties. Gumming disease was also noticed on Purple Transparent and Caledonia Queen canes in Dominica, but was apparently absent from canes inspected in Barbados and Trinidad.

A. K. B.

(1) *Bulletin of Miscellaneous Information*, Royal Botanic Gardens, Kew, No. 7, 1929.

(2) *Report of the Agricultural Department*, Dominica, 1927-28.

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## PLANT AND SOIL RESEARCH.

[*The following summary by W. Pugh, of chemical papers discussed in Section M (Agriculture) at this year's meeting of the British Association, in South Africa, is reprinted from the "Journal of the Society of Chemical Industry," Vol. XLVIII, No.* 34.]

Opening the discussion on soil fertility and its control, Sir John Russell, F.R.S., defined a fertile soil as one which satisfies all the conditions of plant growth, adequately supplying plant nutrients, water, warmth, air for the roots, space for the roots, free from undesirable substances or harmful reaction. The supply of plant nutrients affects crop production in two ways. Other conditions being favourable, the amount of plant growth is increased with increasing supply of nutrients up to a certain point. The relationship is not simple: it can be expressed by two factors, one being the minimal amount in the crop of the particular nutrient, and the other the supply of the nutrient already present in the unmanured soil. Some degree of proportionality between the various nutrients is necessary, but there is no evidence that the ratios are narrow. These relationships are much affected by the water supply. In general, nutrients are most effective when there is a good water supply, and the water is most effective when there is a good nutrient supply. A good water supply thus economises the nutrients, and conversely a good nutrient supply economises water. For fruit the relationships are somewhat different, fruiting and growth being in some ways antagonistic. These relationships are important in irrigation practice.

The second way in which nutrients affect the plant is to change its composition, habit of growth, and response to external conditions, including the attacks of insect and fungus pests. So long as the proportion between the different nutrients is such as to give a normal plant, variations in the total amounts have but little effect on composition or habit of growth; the individual plants may be larger or smaller, but the material of the plant is not much affected. As soon, however, as the proportion of any one element falls too low, certain characteristic effects are produced on the plant, which may profoundly alter its reaction to external conditions, and its chemical composition, and therefore its agricultural value.

In certain conditions any of the elements may thus be in deficiency. Considerable investigation has been made to discover the effects of these deficiencies, and also their symptoms, so that the agricultural expert might be in a position to recognise them. Large excess of certain of the elements relative to the others also produces characteristic effects, which are being studied.

In humid regions deficiency of nitrogen relative to the other elements is common, the result of the ready solubility of the soil nitrates. This reduces the rate of growth and the total amount of growth, but otherwise has little effect on the composition or character of the plant. Nitrogen deficiency is closely linked with the organic matter content and the micro-biological activity of the soil. In the lecturer's experience it does not occur in dry regions.

Phosphate deficiency may arise anywhere, but especially on soils derived from rocks containing little or no animal remains. It reduces the root activity of plants and the tillering of cereals and brings about certain chemical changes profoundly affecting the quality of the produce. Phosphate starved grass is innutritious to animals, inducing phosphate deficiency diseases which have been much studied by Theiler, du Toit, and Green in South Africa.

Iron deficiency is, perhaps, more common than is usually recognised. B. C. Aston first found it in certain New Zealand soils, and traced it to a persistent anaemia of cattle, from which they suffered greatly, and finally died. This was in a wet region on somewhat acid soil, sufficiently light to allow of ready leaching out of the iron from the surface layer. A similar disease is said to occur elsewhere in similar conditions, and may have the same cause. Unfortunately, no easily recognisable symptoms in the vegetation have been observed, but analysis of the ash at once reveals the deficiency of iron. A like deficiency may occur in dry regions: possibly some of the fertilising effect of sulphur in these conditions may arise from an effect on the iron compounds in the soil.

To manganese deficiency has been attributed a disease of oats, and to magnesium deficiency a chlorosis of tobacco.

Potassium deficiency is usually found only in relation to nitrogen excess. When the ratio of nitrogen to potassium becomes large, the plant is considerably altered: its leaves become very dark green, liable to die in discoloured patches, liable also to attack by certain fungi; the percentage of starch or sugar in the storage organs falls off, and the percentage of nitrogen compounds correspondingly increases. The grain of barley suffers in malting quality, the tubers of potatoes suffer in cooking quality, and the roots of sugar beet not only contain less sugar, but yield a more impure juice.

Calcium deficiency is in a different category, being closely linked up with the exchangeable bases in the soil, and with the whole body of its physical and chemical properties. It is most liable to occur in wet regions, where it results in an acid soil. It may occur in dry regions, however, especially where sodium chloride is present, and the sodium has displaced some of the calcium. When this replacement has proceeded beyond a certain stage, the properties of the soil are drastically altered, making it unsuitable for many agricultural crops. This change is of great importance in irrigation areas, and it is an important factor in the evil effects of overwatering.

Mr. C. G. T. Morrison discussed some factors controlling soil fertility, dealing with:—Variations in soil composition; the soil as a succession of changing horizons; change in horizon character with season; the content in exchangeable bases, and in degree of saturation of definite horizons varies through the year; the effect of loss of water upon the pH content of soil suspensions, and upon the exchangeable bases content of the soil; the possible effect of dehydration upon soil fertili y.

In a paper on "Physical factors and their control," Dr. B. A. Keen, Dr. W. G. Ogg, and Prof. N. M. Comber pointed out that the soil moisture is undoubtedly the most important physical factor in plant growth. Measures of control seek, as far as possible, to maintain it at its optimum value, which lies between the deleterious extremes of excess (waterlogging) and deficiency (drought). Methods of soil treatment to encourage rapid drainage of excess water are quite well understood, but there is still very considerable divergence of opinion as to how far it is possible, by appropriate methods of cultivation, to conserve soil moisture in regions of deficient rainfall. It is frequently stated that the preservation of a mulch of dried soil is an effective means of conserving from evaporation the water in the soil below the mulch. On the other hand, extensive work on the influence of moisture on crop production in the Great Plains area of America has led to the conclusion that the loss from a mulched surface is practically the same as from an unmulched one; the effect of cultivation is to prevent weed growth, and hence transpiration losses, and the mulch is, in fact, only incidental. The theory on which the supposed action of a mulch is based likens the soil to a mass of fine capillary tubes up which water can ascend from the free water table to the surface. The mulch is supposed to break these channels, and thus to prevent water in liquid form from rising higher than the bottom of the mulch. Work at Rothamsted and elsewhere has shown this idea to be incorrect, and has also demonstrated that the distance to which water can ascend above the free-water table is much less than that predicted by the laws of capillary rise.

## INSECT NUTRITION.

THE subject of nutrition and metabolism in insects is highly important, in that its adequate exploration is likely to provide fresh viewpoints for problems of insect control. At the same time its relation to such insect products as silk, lac, honey and wax should not be overlooked. At the present time, knowledge of the metabolic processes of insects is limited to scattered experiments and observations, usually confined to individual species, and of too inadequate a character to admit of reliable generalisations being made. The literature is very extensive and, for that reason, imparts the impression that a large amount of work has already been accomplished. A survey of any small branch in this field will, however, reveal how much of the available information is of a comparatively trivial or incomplete character, and what an infinitesimal amount of really fundamental knowledge has, so far, been gained.

In the *Transactions of the Entomological Society of London*, 1928, Part 2, Mr. B. P. Uvarov, senior assistant in the Imperial Bureau of Entomology, has brought together the results of all the work done on the subject of insect nutrition and metabolism. His memoir takes the form of an admirable introductory survey (65 pp.) of the range of problems involved, together with a bibliography of nearly six hundred titles. In the collation and examination of so large a mass of literature, the author has done a substantial service to entomology and laid the basis and provided a guide for future research.

If one selects, for example, the enzymes involved in the digestive processes of insects, rather a surprising amount of data will be found available, but much of the material is the result of old, or of imperfect, methods of technique. There is also the fact that the part played by micro-organisms living in the digestive tract further complicates the subject. The need for clearly ascertaining which enzymes are produced by the insect and which by micro-organisms of symbiotic or other relationship is abundantly evident. With plant-sucking insects we have evidence that they are capable of converting starch into sugars, but we know nothing concerning their utilisation of the protein constituents of cell sap. Buchner went so far as to conclude that the symbiotic micro-organisms of aphids, coccids, &c., are able to utilise atmospheric nitrogen and so make up for a supposed deficiency in nitrogen absorbed by such insects from their plant hosts. It is, however, abundantly clear that there is no positive evidence indicating that sucking insects do not obtain and utilise all the nitrogen they need from the cell contents: we have to admit that the rôle of the symbionts is still unsettled.

Again, the problem of cellulose digestion in insects is very far from being settled in spite of the existence of tens of thousands of plant-feeding species. The presence of a cellulase has been found in very few insects and, for the vast majority of species, it would appear that, if cellulose is digested at all, it is by the intervention of micro-organisms, as has been so well demonstrated by Cleveland in the case of termites. We know surprisingly little concerning the nutritional requirements of blood-sucking insects which are concerned with the transmission of the pathogenic agents of certain virulent diseases. We need to know the length of time such insects can exist in the absence of a blood meal, the extent to which digestion of blood requires the interaction of micro-organisms, the influence of different types of blood upon fecundity, and the extent to which the selection of one mammalian host in preference to another is a chemical or a biological problem.—(A. D. Imms. *Nature*. No. 3110, Vol. 123.)

# MAIZE CHLOROSIS.

## Notes on chlorosis of maize and other gramineae in Mauritius.

By E. F. S. Shepherd, B.S.A.
*Botanist and Mycologist, Mauritius.*

The writer in 1924[3] detected a disease of maize in Reunion Island characterised by the presence of whitish, more or less wavy streaks or stripes on the leaves which he diagnosed as mosaic after a comparison of the symptoms with Kunkel's[2] coloured plates illustrating what he considered to be a type of maize mosaic in Hawaii. Subsequently having detected a disease on maize in Mauritius, which at first sight seemed identical with that in Reunion, he was of opinion that mosaic of maize existed here also.

After the discovery of streak disease on the R.P.8 cane (a Demerara seedling)[1] in Mauritius, the disease symptoms on maize in both Mauritius and Reunion were then considered to be also those of streak. This idea was confirmed by Dr. H. Storey, to whom specimens were sent. At the time, however, some slight difference was noticed between the types of streaking on maize leaves in Mauritius and Reunion respectively, and since the publication of Stahl's paper[5] the writer has been led to the conclusions that the maize disease in Mauritius is Stahl's stripe and not streak disease as described by Storey[6].

Both the coarse and the fine interrupted types of striping, and specimens showing the chlorotic bands, as described by Stahl[5], have been encountered here. The writer still believes, however, that the disease on maize in Reunion is identical with streak disease after a comparison of the symptoms with photographs of streak diseased maize leaves kindly forwarded by Dr. Storey.

The differences between the symptoms of stripe and streak appear to be as follows:—

The leaf markings in the coarse type of stripe disease are less wavy in outline, wider and more uniform in width than those in streak, which seem to widen out at intervals in the form of knots. In the fine interrupted type of stripe the leaf markings are usually more broken, more uniform in width, less wavy in outline and narrower than those in streak. Even when the interrupted stripes run together, they retain their characters of width and outline and are thus distinguishable from the streak leaf markings.

The two diseases are also apparently distinct, chiefly because of their different respective vectors, as pointed out by Brandes[1] at the Havana 1927 Conference. *Balelutha mbila*, the streak vector[7] and *Peregrinus maidis*, the stripe vector, have not yet been recorded in Mauritius. Searches are being made for one or both of these insects, transmission experiments with which only will permit of a definite opinion being formed as to the identity of the virus disease or diseases of maize here.

The fact that the most common chlorosis of maize in Mauritius is apparently *stripe* and not *streak* suggests the possibility that the so-called *streak* disease of R.P.8. cane and several species of wild grasses here may be *stripe* or some other virus affection or affections. If this theory is substantiated by experiment, it will help to explain the chief difference in behaviour between the R.P.8 disease here and streak of cane in Natal, which is that whilst Uba cane in that country is widely infected with streak it is free from the disease in this colony.

Up to the present, the disease has shown no signs of spreading here and is responsible for negligible losses on the R.P.8 cane, but in view of the increasing popularity of this variety on account of its comparatively high yielding and disease resisting qualities, and the possible increase in spread of the disease and its cumulative effect on plants raised from infected cuttings, the application of precautionary measures, *i.e.*, roguing of diseased stools and selection of healthy planting material is necessary.

The maize disease also has not caused any concern in Mauritius, because the crop is of minor importance at present and the percentage of infection is in most cases low. The vegetative vigour of affected plants is, however, seriously impaired.

"Roguing" of diseased plants is recommended, in addition to keeping maize plantations clear of weeds, especially wild grasses, which may harbour the disease and be conducive to the increase of insect vectors.

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(7) Storey, H. H., "The transmission of Streak Disease of Maize by the Leaf Hopper, Balelutha mbila Naude." *Ann. Applied Biology*, XII, No. 4, pp. 422-439, November, 1925.

## DWARF COCONUTS.

THE *Malayan Agricultural Journal* for June, 1929 (Vol. XVII, No. 6) contains an article called "Observations on the Dwarf Coconut Palm in Malaya" by H. W. Jack and W. N. Sands. This is in some respects a continuation of an earlier paper ("The Dwarf Coconut in Malaya") published by the same authors in 1922 (*Mal. Agr. Jnl.* 10, pp. 4-12) and it affords a great deal of useful information about this crop.

In the earlier paper the authors expressed the opinion that dwarf coconuts originated as mutations from the common tall types, but their exact origin is not known. There are a number of dwarf races of the coconut palm known in various parts of the Eastern Tropics, and many of them are apparently distinct. These notes refer only to the types commonly grown in Malaya.

The Malayan dwarf coconut is itself not one type, but three, characterized by ivory-yellow, apricot-red, and green fruits respectively. There is evidence of genetic variability within these races, in size of nut for example, but it appears that, owing to the fact that these dwarf palms are commonly self-pollinated, they are much more nearly uniform than any tall types known, especially the yellow race. In plantings made at the end of 1920, with nuts from an estate where other varieties occur, the percentages found true to type on germination were :—Yellow 96.2 per cent., red 74.6 per cent., green 68.7 per cent.

The more recent "observations" comprise careful records from germination up to an age of seven years of five palms of each of the three races. The seed nuts were sown on 6th June, 1921. Germination was uneven, but this may have been due to differences in the age of the nuts. The young seedlings were planted out on 11th December, 1921, and the first flowered on 20th September, 1924, and the last on 16th April, 1926. Both the first and the last to flower were "green" palms, which appear to be less uniform genetically than the yellows and reds. The latter all flowered between three years 170 days and three years 301 days from germination.

Spadix production was recorded, and found to be fairly well distributed throughout the year, due no doubt to the fact that the water supply was ample for the requirements of the palms at all times. The average interval between the opening of successive spathes was twenty days. The early flowering and fruiting was very uneven, especially of the greens. In the second year of fruiting, however, the palms produced almost an average crop, and appeared to reach full production at about the third year, though the records have not yet covered a sufficient number of years to establish this point definitely.

The maturation period of the fruit, which cannot be measured exactly, was estimated at about thirteen months, with the yellow fruits about one month earlier than the others. Out of 642 nuts taken from the observed palms and germinated, only three of the plants produced were not true to type so far as colour is concerned, which shows that very little crossing can have taken place, and supports the authors' opinion that by planting these dwarf races the advantages of having practically pure types may be secured.

Comparison between the three races shows that the yellow type, although the most popular, produces a smaller fruit yielding less copra per nut than either of the others. Figures of estate production from three estates, which show that on the average 407 "green" nuts were equivalent to 453 "red" or 508 "yellow," indicate approximately the relative values of the three as copra producers. It remains to be added that the "meat" from the yellow type appears to be more difficult to cure, possibly on account of high sugar content. Furthermore, the yellow type appears to be more readily subject to pest attacks, and less resistant to poor conditions generally, than either the green or the red. The green type is the hardiest.

Comparison of dwarf with tall coconuts from the standpoint of production is made on the basis of estates' figures. It is estimated that sixty-four dwarfs can produce as much copra as fifty talls. Whereas fifty tall palms plant an acre, the same area will carry ninety dwarfs, so that the dwarfs show an advantage by the production of twenty-six palms per acre. Also, dwarf palms are mature three or four years earlier than ordinary tall palms, and produce profitable crops from their fifth year onwards.

The authors are evidently of opinion that this advantage is due less to any inherent superiority of the dwarf over the tall as such than to the fact that the former are almost uniform high-yielding races, whilst the latter are much more mixed. They point out that many of the tall palms they have studied have produced an average of eighty-five nuts and over per annum (over an eight-year period) so that apart from the question of early maturity of the dwarfs, if tall forms could be obtained which would breed true, as the dwarfs appear to do, to the character of high yield, then these would prove superior to the dwarfs in yield of copra per acre, and perhaps in other ways.

Unfortunately, no tall types approaching genetic purity are yet available, and we may therefore quote in appropriate conclusion from the authors' own summary of their observations: "It is shown that, given suitable conditions and fair treatment, the dwarf palm (particularly the green race) is a sound commercial proposition."

E. E. C.

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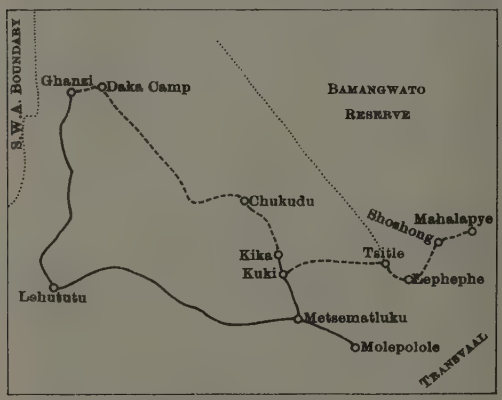
ACCORDING to Returns of the Vital Statistics of Non-native Officials in West Africa the 1928 death rate of 6.7 per 1,000 and the invaliding rate of 11.7 per 1,000 are the lowest on record.

## TROPICAL WORLD NOTES.

### *Bechuanaland.*

The Bechuanaland Protectorate Report for 1927-28 contains an interesting account of two valuable expeditions through unexplored country which were carried out in the Kalahari desert on the recommendation of the European Advisory Council for "the purpose of exploring a cattle route to the Western border, starting in the neighbourhood of Lephephe and travelling north-west or nearly so and again starting, say, from Ghanzi and travelling south-east with a view to ascertaining the possibilities of a sufficient water supply." The country to be explored forms an equilateral triangle with sides about 200 miles long, entirely devoid of markings, almost in the centre of the Territory; the proposed route almost bisecting this triangle. The first expedition which was under the leadership of Lieutenant Beeching, Sub-Inspector in the Bechuanaland Protectorate Police, and comprised a scotchcart and oxen, five camels, six native policemen and two bushman guides, started early in March 1928 from Daka about 30 miles east-north-east of Ghanzi, travelling south-east. Progress was slow: rain sometimes held the expedition up and every foot of the way had to be cut through the dense bush on either bank of the great Okwa river.




SKETCH MAP OF ROUTE FROM MAHALAPYE TO GHANZI.

The bushman guides were always an anxiety as each guide would only go to the limit of his hunting grounds, where another guide had to be found. Plenty of water was found in limestone pans fairly evenly scattered along the route, abundance of big game and many bushmen armed with bows and arrows. The expedition eventually reached Metsematluku in April having thus established, during the rains at any rate, a practical cattle route (of between 280 to 300 miles from the valuable Ghanzi grazing lands) which represented almost half the distance of the existing route *via* Lehututu. Cattle have since come safely through.

The second expedition was undertaken with the object of linking up Mahalapye with the new route, so as to provide the shortest possible route to the railway line, to locate suitable places for sinking wells, to ascertain whether it was possible to utilize and test motor transport, of British make, for traversing the desert, and to report upon the country traversed and the uses to which it might be put. Two lorries were used for this expedition. The party consisted of the Imperial Secretary, Lieutenant Beeching, Mr. W. Grantham, Mr. Makin, two chauffeurs, Native Corporal Hendrik, a native cook and three native constables. The party which started from Mahalapye journeyed *via* Shoshong, Lephephe, (where the limestone formation was everywhere in view), Tsitle to Kuki where Beeching's route was picked up to Ghanzi. Many difficulties were encountered. To economize water and diminish dust trouble it was decided to travel at night. At Kuki where water had been confidently expected the last drop in the pan had evaporated. Punctures averaged twenty a day from stumps of dead trees lying just beneath the sand. A number of pans beyond Kika were passed which were dried up. These pans are situated in crater-like depressions and, when dry, reveal a limestone bed. Farmers at Ghanzi subsequently explained that, when sinking their wells, they have to dig through this solid limestone for 40 to 60 feet, when a bluish white shale, apparently composed of a mixture of clay and limestone pebbles, is encountered. Through this the water does not penetrate, and after digging into it from 10 to 15 feet a perennial supply of water is obtained. Natives were found who slaked their thirst with bulbs and melons and the poundered leaves of a certain shrub, and women who carried in skins on their backs a large number of ostrich eggs full of water which they subsequently buried in the ground. At one point of the journey the lorries had averaged three miles to the gallon and used 25 gallons of water. After encountering open grassy plains with a very large acreage of good grazing, dried river valleys, bush and heavy sand the expedition eventually reached Ghanzi early in July.

It is worth recording that neither on Lieutenant Beeching's pioneer trek nor on this journey of the lorries through the alleged "Kalahari breeding ground" was a single locust seen, nor yet the signs of any. No large communities were found to exist or were heard of as existing in this huge unknown country but it is probable that the primitive family group system prevails. Nomad Bushmen hunting with the lion and driving him from his kill, feed on the meat to utter repletion and live on that one feed through days and perhaps weeks of famine, working when required for a tribe known as the Bakgalagadi who themselves live together in small villages, at intervals going away to serve for a time members of the neighbouring Bechuana tribes.

The expedition did not remain at Ghanzi but continued on a 500 mile trip northwards with the object of discovering a route from Ngamiland to the Zambesi along which cattle might travel without encountering the tse-tse fly. The great

cattle trade of Ngamiland and Ghanzi with the Belgian Congo is constantly menaced by the fact that cattle apparently healthy when they leave the Territory reach their destination with the disease upon them. To fight this pest the Administration has so far only been able to seek new routes as the fly advances further east. The expedition called on one Dutchman farmer *en route* and Captain Clifford has recorded his unstinted admiration for the cleanliness of the place and the manner in which these people had maintained European standards in so lonely an outpost. They passed through open country, with patches of heavy sand, frequent limestone out-crops, and occasional pans. There was a welcome stretch of flat loamy country through thick bush, and generally the road was good all along the shores of Lake Ngami as far as Totin. Lake Ngami, as they saw it, was a vast expanse of rich, black alluvial soil, but in recent years the July floods have reached it, and one-third to one-half of its surface has been under water. This part of the Territory is well within native reserve, but here, and in the beds of the feeding rivers or other spillways from the Okovango when they are dry, there may be future possibilities of cultivation for export, if only the transport problem can be solved. Cotton and rice leap to the eye as possible crops for which there is abundant demand. Both the Mokyotse aloe, the fibre of which resembles hemp or jute, and the papyrus plant flourish locally.

The expedition arrived at Kasane on 10th July and at the Victoria Falls the next day. Difficulties with the lorry big end bearings and tyres notwithstanding, the 300 miles from Maun were accomplished in three and three quarter days. It is all good grazing country, and is also Crown Lands. This route is often taken nowadays by motor-cars, usually without mishap.

As to the new cattle route from Ghanzi, the Administration is sending a boring machine to sink wells every 50 miles from Metsematluku to Daka for a start, after which the route from Lephephe to Kika will be prospected with a similar object.

* * *

**Ceylon.**

Exports of coconut products from Ceylon during 1927 showed a total fall in value of Rs. 2,072,744 which was mainly accounted for by a small fall in crops, particularly in the second part of the year as the result of short rainfall during the previous twelve months. An investigation carried out by the Department of Agriculture on the exports of coconut products as well as of the annual quantity of nuts utilised since 1911, revealed that the average annual export for the period 1923-26 was 89 per cent. in excess of the basic average, or a rate of increase equal to 5.6 per cent. per annum. This was mainly attributed to young plantations coming into bearing and to a higher state of cultivation.

**Gambia.**

According to the Annual Report on the Trade and Shipping of Gambia for 1928, the total value (exclusive of specie) of the trade during the year under review was £2,166,695, an increase of £304,319 as compared with 1927. This is the highest total attained since 1920. The ground-nut crop last year exceeded expectations, and left an exportable surplus of 74,442 tons, valued at £1,092,790, being an increase of 9,335 tons, valued at £176,599, compared with the previous year. The distribution of the trade between the four principal competing countries during 1928 and 1927 was as follows :—

| Country. | 1928. | 1927. |
|---|---|---|
| | per cent. | per cent. |
| France .. | 33.15 | 44.43 |
| United Kingdom | 32.68 | 6.48 |
| Germany .. | 20.00 | 20.39 |
| Holland .. | 6.40 | 20.38 |

* * *

**Sierra Leone.**

According to the *Provincial Administration Report* for 1928 one of the most successful experiments undertaken in the Central Province of Sierra Leone by the Department of Agriculture was the encouragement of swamp rice growing. Wherever it has been tried it has been successful and taken the native's fancy. Sufficient stocks of seed rice are now available in every district for each village to have a trial farm and soon the amount of rice harvested should begin to be a factor in the food stocks of the country.

The planting of coffee on a large scale is also receiving the attention of the Department and the first results are encouraging. The local market for this product is still unsatisfied and much money goes out of the country in importing stocks. 1*s.* and 1*s.* 3*d.* per lb. is a common price asked for the most ordinary green bean. There are now model plantations at various points in the province, and when these come into bearing and the native sees the price he can get for the produce the success of the venture is assured, for beyond the local market there is a large Home and Continental market ready to absorb all Sierra Leone can turn out.

During the year two forest reserves were established by law. These climatic reserves, the main purpose of which is to conserve the water supply, are beginning to be understood by the natives, who at first looked askance at their formation. A word of praise must be given for the loyalty of the native in respecting the reserves once established. The guards provided are but few in number and many are far removed from supervision yet charges of violating the reserves are almost non-existent.

## SUGAR NOTES.

*Compiled by the College Department of Sugar Technology.*

### Bacterial-Vascular Diseases of the Sugar Cane.

*D. S. North, Bull. No. 36, 3rd Conf. Intern. Soc. Sugar Cane Technologists,* 1929.

The author gives a brief summary of knowledge respecting gumming disease and leaf scald. It is now definitely known that gumming disease is carried from leaf to leaf by wind-blown rain and by flies; the causative bacteria thus transported find entrance to new posts through the leaves that become scratched, split, torn, or bruised by being blown about and rubbed against each other. No immune cane varieties are known, though there are some which are highly resistant and can be cropped without damage. The chief obstacle to the control of the disease in Australia is the system of small holdings over which control measures cannot be uniformly applied.

Leaf scald seems to be disappearing from most of the sub-tropical regions of Queensland through the introduction of resistant varieties; the chief factor in its dissemination is apparently that Badila cane behaves as a tolerant carrier; H. 109 is proving highly resistant.—(*Facts About Sugar,* Vol. XXIV, No. 32.)

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### The Present State of Cane Breeding in Java.

*O. Posthumus, Bull. No. 35, 3rd Conf. Intern. Soc. Sugar Cane Technologists,* 1929.

Cane breeding work in Java is now narrowing down to a relatively few lines of parentage. New varieties that could compete wi h P.O.J. 2878 are to be expected only from a few families, particularly those of Kassoer descent. Experience rules out Chunnee blood and all crossings of the commoner noble canes *inter se.* There is still some expectation of new elements from different "glagah" forms from other countries, especially those gathered by the Brandes New Guinea expedition, and from crossings made with noble canes from the West Indies which heretofore have been neglected by the Java breeders.

The greatest chance for high yielding canes seems to be in the fourth "glagah" nobilitation; a new seedling of this description, P.O.J. 2952 is to be tested in competition with P.O.J. 2878. The narrowing of the field of parentage by exclusion of combinations from which little is to be expected has the advantage that more time and space are gained for testing a larger number of seedlings from lines that have heretofore yielded superior canes. The facilities for cane breeding in Java have lately been greatly improved by the addition of new breeding gardens in localities where the conditions for flowering are very good.—(*Facts About Sugar.* Vol. XXIV, No. 32.)

### Experiments on Burning Cane.

*H. H. Dodds and P. Fowlie, in S. Afr. Sugar Journal,* Vol. XIII (1929), pp. 287-289.

This is a report of a continuation of experiments on cane burning begun in South Africa in 1927. During the present season the burnt and unburnt cane showed the same relative differences in keeping quality as was observed in previous years, but the rate of deterioration this year in each case was much slower, due perhaps to the earlier date and cooler weather during the experiments.

The unburnt cane deteriorates much more rapidly than the burnt cane, especially where the latter is left standing. However, the ultimate effect of burning is believed to be injurious from the agronomic standpoint, owing to destruction of humus. The experiments indicate, however, that where cane is not burnt it is necessary to get it to the factory as soon as possible after cutting especially when harvested late in the season with warm weather prevailing. A little more latitude is available for burnt cane, since there is an initial period of four days or more over which there appears to be little or no loss or deterioration.

When a larger quantity of cane is burnt, accidentally or otherwise, than can be got to the factory within four days, it is better to leave the cane standing in the field until transport is available, since it will keep much better before being cut.

These experiments apply only to the Uba cane, which is a variety reputed to have very good keeping qualities.—(*Facts About Sugar,* Vol. XXIV, No. 33.)

* * *

### Synthesis of Cane Sugar.

Some doubt having been thrown on the synthesis of cane sugar recently effected by Pictet and Vogel, these authors have given in the June issue of the *Berichte* of the German Chemical Society very detailed experimental directions for the synthesis. It is clear that extraordinary precautions have to be taken to obtain successful results, and the failure of other experimenters, in the absence of these details, could readily be expected. It is necessary to follow precisely a definite method in each of the stages of the synthesis, involving the preparation of the *y*-tetra-acetyl fructose, the condensation of the tetra-acetate of glucose and of the *y*-fructose, the isolation of the octo-acetate of cane sugar, and the saponification of the latter. The publication of these details, which were withheld in the first publication, will enable other chemists to repeat the work with more hope of success, and the reality of this important synthesis will no doubt be confirmed.—(*Nature,* Vol. CXXIV No. 3121.)

SOILS AND FLORA.

Figs. 5 and 6.—*Two examples of virgin forest vegetation. Tall trees, of considerable girth, covered with climbers and epiphytes form a dense overhead canopy. Ground vegetation is relatively scanty and the underlying soil is good.*

## SOILS AND FLORA.

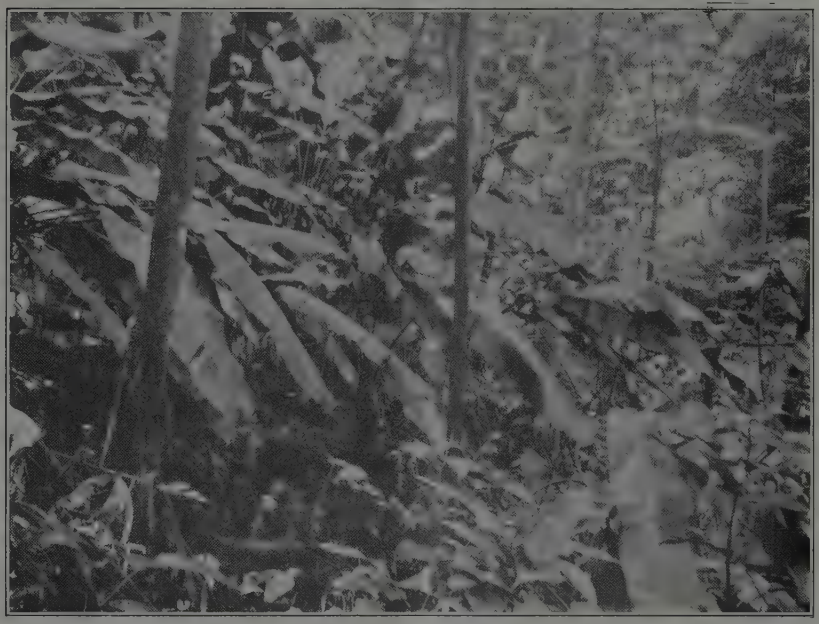

FIG. 7.—*A well grown secondary forest, with Heliconia bihai (Balisier or wild banana) in dense clumps, Cyathea and Cecropia and other trees of slender girth.*

FIG. 8.—*A typical peasant 'garden' planted with Tannia, and showing the partly burnt felled timber and exposed soil. Such a 'garden' will be abandoned after two years.*

## CHEMICAL NOTES.

*Compiled by the College Department of Chemistry and Soil Science.*

### Forced Ripening of Bananas.

Ethylene has been used for some time for forcing the ripening or yellowing of citrus fruits, and for blanching celery. These changes concern chiefly the destruction of chlorophyll by oxidation, which appears to be accelerated through the catalytic agency of ethylene. The process seems to have little action on chemical transformations of substances contained in the fruit-juice and within the inner fruit tissues of citrus.

Investigations into the effect of ethylene on unripe bananas (Regeimbal, Vacha and Harvey, *Plant Physiol.*, 1927, 2, p. 357) show, however, that in this case, the treatment causes a rapid increase in sugar content of the pulp, at the expense of starch. Treated bananas were found to contain as much as 25 per cent. more sugar (and correspondingly less starch) than untreated bananas. The amount of ethylene employed was one part in 1,000 parts of carbon-dioxide-free air. The temperature was 25°C, and the time of contact, 20 minutes. Determination of the rate of carbon-dioxide production during the periods when the ethylene treatment was applied, showed that the respiration rate of the treated bananas quickly trebled, but soon became normal again, and then subnormal, owing either to increased oxidation, or to change in permeability of the cell membranes. Evidently the activities of the diastatic and of the respiratory enzymes are increased by ethylene treatment of unripe bananas.

* * *

### The uses of Ethylene.

Ethylene, the gas now used extensively to bring stored fruits to a ripe colour, to blanch celery, and for other purposes, appears to be harmless to animal life if there is not much of it in the atmosphere. Furthermore, it has no effect on most of the processes of digestion, and may even facilitate the digestion of starch. These conclusions appear to be justified on the basis of a report made by Dr. Arthur Hirschfelder and Elmer T. Ceder, of the University of Minnesota. They report that young rats given water saturated with ethylene did not have their growth checked by it, nor did other rats suffer slowing down of growth when they lived in an atmosphere containing a low concentration of the gas. An atmosphere containing 1 per cent. of ethylene, however, did inhibit growth. Pepsin, trypsin, and lipase, digestive juices that act on proteins and fats, were neither helped nor harmed by being saturated with ethylene, but amylase, the principal digester of starch, had its action augmented by similar treatment. It is stated, however, that ethylene alone did not convert starch into sugar.—(*Science Supplement*, Vol. LXX, No. 1811.)

### A Synthetic nitro-phospho Compound.

Pumping a nitrogenous gas through crushed and moistened phosphate rock is expected to yield an improved commercial fertilizer according to Edward J. Fox and Dr. J. W. Turrentine. Their researches were the result of a desire to find a wider use for the products of manufacturing plants that capture nitrogen from the air and combine it with other elements to form fertilizer material and other chemicals. The three mineral nutrients needed in largest quantity by most crop plants are nitrogen, phosphorus and potassium. The United States of America has large deposits of phosphorus-bearing rocks of various kinds, and if the same mineral can be made to carry nitrogen as well as phosphorus, there will be that much less dead weight to transport to the field. The two government chemists found that by passing nitrogen, in the form of nitrogen peroxide, through slightly moistened masses of phosphate rock, they could secure the combination of a considerable proportion of this valuable element with the phosphates, at the sacrifice of a fraction of the phosphorus. This makes a double fertilizer out of the rock, leaving only the potash to be added. The work so far has been on an experimental basis, and the problems of factory scale production have yet to be solved. But Mr. Fox and Dr. Turrentine are confident that this end can be successfully attained. —(*Science Supplement*, Vol. LXX, No. 1811.)

* * *

### The use of Ferrous Sulphate on coconut plantations.

M. Bodin reports extraordinary results obtained by adding ferrous sulphate to soils growing coconuts in the Fakalina and Pukapuka plantations in French New Guinea. From his description, it appears that the soil of these plantations is highly calcareous, and that the coconut palms growing in them suffer chlorosis*, which may be of the lime-induced type so familiar to growers of fruit trees in certain temperate regions. Apart from their high lime content, the soils are comparatively rich in plant nutrients.

The ferrous sulphate treatment consists in spreading pure crystals of the compound in small pieces at a distance of 3 feet from the palm stems. About 300 grams (half a condensed-milk tin full) of crystals are applied to each tree every year. The cost is one franc per tree per annum.

In an experiment, a row of 60 trees, 10 years old, planted 25 feet apart, yielded 2,000 kilograms (about 4,400 lb.) of copra per year after treatment 3 times in 9 years with ferrous sulphate applied at the above rate. A similar row not treated, yielded only 350 kilograms of copra (about 770 lb.). The recommended ferrous sulphate treatment has recently been taken up with very satisfactory results all over the Island. It is pointed out that the successful use of ferrous sulphate is very doubtful when applied to coconuts growing on poor soils.

* *See* also an article on "Lime-induced Chlorosis in Plants" by F. Hardy in *Agricultural News*, Vol. XIX, 1920, No. 487.

## REVIEWS.

HEXOSAMINES AND MUCOPROTEINS. P. A. Levene. *Longmans, Green & Co.*, London, 1925. Pages 163.

This is one of a series of monographs on biochemistry edited by Dr. R. H. A. Plimmer and Sir F. G. Hopkins, who has obtained a very wide reputation.

The author deals with these complex groups of substances in so thorough a manner that the reader, whilst enlarging his own knowledge considerably, is impressed more forcibly than ever by the enormous number of problems still requiring solution.

As a description of our present knowledge of the subject, to which the author has contributed probably more than any other single man, this book is extremely valuable.

R. H. H.

* * *

A HANDBOOK FOR CANE-SUGAR MANUFACTURERS. Guilford L. Spencer, D.SC. Sixth Edition, Enlarged. Second Impression, Corrected. *Chapman & Hall, Ltd.*, London. Pages 561.

This book is so well known as to require little description. No sugar man's library is complete without it. The arrangement and the printing of the book leave nothing to be desired, and the carefully compiled reference tables are particularly valuable. This book is more in use than any other in the laboratory of the Sugar Factory of this College.

R. H. H.

## BOOKS RECEIVED.

WE have to acknowledge the receipt of the following books :—

**AGRICULTURE.**

**Sisal, Production and Preparation.** H. Hamel Smith, *John Bale Sons & Danielsson, Ltd.*, 1929, pp. 384, 15*s*.

**GENERAL.**

**Nelson's West Indian Arithmetics; Introductory, and Books I to III, Teacher's books, Introductory and Books I to III, Pupil's Books** (illustrated). J. O. Cutteridge, 11*s*. 6*d*. the set. *Thomas Nelson & Sons, Ltd.*, 1929.

**MYCOLOGY.**

**Microbiology.** B. J. Lutman. *McGraw Hill Book Co., Inc.*, 1929, pp. 496, figs. 211, $4.

## ACKNOWLEDGMENT.

WE have to acknowledge, with thanks, the gift of "A Notebook of Agricultural Facts and Figures," compiled by R. C. Wood, M.A., Madras Department of Agriculture, Fourth Edition, Government Press, Madras, presented by Professor R. C. Wood.

## COLLEGE NEWS.

The Principal returned from England by s.s. *van Rensselaer* on 28th September.

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Mr. H. H. Croucher, Lecturer in Chemistry, and Mrs. Croucher arrived in Trinidad by s.s. *Ingoma* on 28th September.

* * *

Mr. G. A. Jones Assistant Commissioner of Agriculture for the West Indies has been appointed as Adviser to the Sugar Commission.

* * *

Mr. C. Y. Shephard, Professor of Economics, and Mr. R. E. Hunter, Lecturer in Botany, accompanied by 26 Students arrived by s.s. *Cavina* on 5th October. Miss E. Kerr of the Clerical Staff returned by the same opportunity.

* * *

The Principal has been requested by the Secretary of State to attend the first session of the Sugar Commission in Barbados. He left for that Colony with Mr. Jones by the s.s. *Dominica* on 15th October, and expects to be away for about a fortnight.

* * *

Mr. J. G. Davies, Assistant Sugar Technologist, and Mr. R. C. Wood, Professor of Agriculture, and Miss Wood arrived in Trinidad by s.s. *Carare* on 21st September. Mr. A. Pickles, whose appointment as Entomologist under the Froghopper Investigation Committee, was announced in our last issue, arrived by the same opportunity.

* * *

Mr. W. Scott, Professor of Sugar Technology, who sailed for England by s.s. *Coronado* on 19th April returned by s.s. *Matura* on 3rd October. Professor Scott represented the College at the International Congress of Sugar-cane Technologists which was held in Sourabaya, Java, from 7th June to 21st June. Besides studying sugar conditions in Java where he visited a number of research centres, he also went to the Hawaiian Islands where much valuable information was also collected.

* * *

The following recently visited the College: Mr. A. S. Jelf, M.A., Colonial Secretary, Jamaica, and Mrs. Jelf; Rear-Admiral E. H. Campbell, U. S. Navy and Mrs. Campbell; Mr. R. H. Whitbeck, Professor of Economic Geography, Wisconsin University, U.S.A.; Mr. G. McClean Deputy Manager, Rose Hall Plantation, Berbice; Mr. J. C. Du Boulay, St. Lucia; Mr. G. D. Pile, Barbados; Mr. J. T. Runed and Mr. S. Skedserro, Oslo University, Norway; Mr. K. A. Kelvey, Venezuela; Mr. A. N. Smallwood, and Mr. H. H, Skipper, Admiralty, London; Mr. C. K. Smith, Trinidad; and Mr. K. Reid, Tobago.

## COLLEGE SESSION 1929-30.

THE College session for the year 1929-30 commenced on the 7th October. The following Students are taking the Diploma Course:—

*1st Year*:

Messrs. Edgar Laurence-Trott, V. A. Pope, D. H. Searle and I. C. Young (England); Jenarine Singh (British Guiana); A. C. Packer (Trinidad and England); M. N. Lucie-Smith and L. L. de Verteuil (Trinidad); H. L. Manning (Barbados); S. A. Schouten (Anguilla); L. C. W. Greaves (St. Kitts); and J. M. Cave (Barbados).

*2nd Year*:

Messrs. J. de la Bastide and J. L. Goellnicht (Trinidad); G. B. Gregory (British Guiana).

*3rd Year*:

Messrs. C. K. Robinson (Trinidad); J. F. Williams and E. S. A. Chin (British Guiana); A. F. Nichols and C. A. S. Hynam (Barbados).

*4th Year*:

Mr. H. L. Grogan (Barbados).

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The Colonial Office Students are as follows:—

Mr. J. R. Curry, N.D.A., C.D.A. (Durham).
Mr. N. R. Fuggles, B.Sc., Agric. (Lond.), Dip. Agric. (Cantab.), Dip. Agric. (Wye).
Mr. G. Griffith, B.Sc., Ph.D. (Wales).
Mr. R. Johns, N.D.A., C.D.A., C.D.D. (Aberystwyth).
Mr. H. D. Leighton, N.D.A., Dip. Agric. (Glasgow).
Mr. R. J. A. W. Lever, B.Sc. (Durham).
Mr. G. W. Lock, N.D.A., N.D.D., C.D.A. (Midland Agric. College).
Mr. B. A. Lowe, B.A. (Cantab.), Dip. Agric. (Cantab.)
Mr. J. P. Maule, B.A. (Cantab.), Dip. Agric. (Cantab.)
Mr. H. L. G. Milne, N.D.A., C.D.A. (Harper Adams Agric. College).
Mr. F. B. Notley, B.Sc. (Birmingham).
Mr. G. M. Roddan, B.Sc., Agric. (Glasgow), N.D.A.
Mr. J. B. G. Savory, Dip. Agric. (Wye).
Mr. A. B. Stark, N.D.A., C.D.A. (Durham).

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The Empire Cotton Growing Corporation Students are as follows:—

Mr. R. P. Davidson, B.Sc., Agric. (Edinburgh), N.D.A.
Mr. S. T. Hoyle, B.A. (Cantab.).
Mr. A. J. Kerr, B.A. (Cantab.).
Mr. E. O. Pearson, B.A. (Cantab.).

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The following Students are taking Special Courses:—

Mr. C. G. Akhurst, B.Sc. (Lond.), A.R.C.S. (Salter's Exhibition), (England).
Mr. E. G. A. Benson, B.Sc., Agric. (Lond.) (British Guiana.)
Mr. G. Des Grottes (Martinique).
Mr. H. McLuskie (British Guiana Department of Agriculture) (England).
Mr. J. E. Mill (England).
Mr. C. A. Thorold, B.A. (Oxon.).
Mr. J. West, B.S.A. (McGill).
Mr. J. A. Wirshing (Porto Rico).

The following Students are taking "Refresher Courses":—

Mr. J. L. Scott, B.Sc. (Edin.), Assistant Superintendent of Agriculture, Gold Coast.
Mr. J. Steele, N.D.A., N.D.D., Assistant Superintendent of Agriculture, Gold Coast.

## APPOINTMENTS.

The following appointments of Students in residence at the College during the session 1928-29 have been notified by the Secretary of State for the Colonies:—

Mr. R. G. H. Wilshaw, B.A., Assistant Agricultural Chemist, Federated Malay States.

Mr. W. B. Hutchinson, N.D.A., District Agricultural Officer, Tanganyika.

Mr. R. D. Linton, District Agricultural Officer, Tanganyika.

## COLONIAL APPOINTMENTS.

The following appointments have been made by the Secretary of State for the Colonies during the months of July and August, 1929:—

Mr. H. Macluskie, Agricultural Superintendent, British Guiana.

Mr. F. C. Cooke, B.Sc., A.R.C.S., Assistant Chemist for Copra Investigations, Federated Malay States.

Captain H. M. Stuchbery, B.V.Sc., Government Veterinary Officer, Agricultural Department, Fiji.

Mr. S. Simpson, M.R.C.V.S., Veterinary Officer, Gold Coast.

Mr. I. A. Beveridge, B.Sc., Assistant Conservator of Forests, Gold Coast.

Mr. A. G. Turner, Citrus Specialist, Palestine.

## SPORTS.

AT a general meeting of the Imperial College Amalgamated Clubs held on 8th October, the following Students were elected officers of the several clubs:—

| | |
|---|---|
| *Chairman, Junior Common Room* | Mr. J. Steele. |
| *Rugby Captain* | Mr. H. L. G. Milne. |
| *Association Football Captain* | Mr. R. Johns. |
| *Hockey Captain* | Mr. C. G. Akhurst. |
| *Cricket-Captain* | Mr. N. R. Fuggles. |
| *Tennis Captain* | Mr. G. M. Roddan. |

OUR thanks are due respectively to Messrs. R. A. Lister & Co. and to Messrs. Lee, Howe & Co. for their valuable gifts of a 1½ H.P. petrol engine and of a 3 inch centrifugal pump. These were supplied by Mr. C. H. Haywood, Port-of-Spain, and have now been installed on the College Farm as an irrigation plant.

## TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Market have ranged as follows: (*c.i.f.* per cwt.)

| | *Foreign.* | | *Preferential.* | |
|---|---|---|---|---|
| | *s.* | *d.* | *s.* | *d.* |
| 4th September .. | 8 | 10½ | 12 | 6 |
| 14th September .. | 9 | 4½ | 13 | 0 |
| 18th September .. | 9 | 3 | 13 | 0 |
| 26th September .. | 9 | 6 | 13 | 3 |
| 3rd October .. | 9 | 9 | 13 | 6 |
| 11th October .. | 9 | 3 | 13 | 0¾ |

At the beginning of September *C. Czarnikow Ltd.* issued Dr. G. Mikusch's estimates of the probable production in Europe during the coming season, which revealed an increase of some 60,000 tons in spite of reductions in sowings. Later reports, however, were rather less favourable owing to the drought experienced on the Continent and prices, in consequence, have tended to move upwards. Another factor which is undoubtedly lending support to the market is the strength with which the unsold balance of the Cuban crop is being held by the single selling organisation. Also, there is a much more optimistic feeling in the market as it is now more widely realized that the period during which the prices of as important an article as sugar can remain at such a low level, must sooner or later come to an end.

* * *

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association:

| | *American Mid.* | *Egyptian F. G. F. Sakel.* | *Sea Island.* | | |
|---|---|---|---|---|---|
| | | | *Good.* | *Extra fine.* | *Prices paid this Week.* |
| | $ c. | $ c. | $ c. | $ c. | $ c. $ c. |
| 16th Aug. .... | 10.10 | 16.50 | 25.50 | 38.00 | — |
| 23rd Aug. .... | 10.32 | 16.65 | 25.50 | 38.00 | 24.00-25.00 |
| 30th Aug. .... | 10.58 | 17.25 | 25.50 | 38.00 | 23.50-28.50 |
| 6th Sept. .... | 10.46 | 17.50 | 25.50 | 38.00 | 22.25-27.50 |
| 13th Sept. .... | 10.32 | 17.65 | 25.50 | 38.00 | 11.00-27.00 |
| 18th Sept. .... | 10.31 | 17.45 | 25.50 | 38.00 | — |
| 11th Oct. .... (local) | 10.28 | — | 25.50 | 38.00 | — |

The situation in August was wrapped up in the prospects of the American crop as influenced by the Texas crop which, owing to a drought was estimated to show a large reduction. In the second week of September, however, the drought broke in the western belt and with considerable liquidations from all sources prices were adversely affected. The Bureau's report showed a crop estimate of only 14,825,000 bales compared with the August figure of 15,543,000 bales, but the subsequent advance of 20 points was considered disappointing.

* * *

COCOA.—The Accra main crop is now coming to market and with heavier stocks on hand, compared with same period last year, prices are somewhat weaker. The higher grades have moved in sympathy as demand is slow.—(*By courtesy of the Cocoa Planters' Association Trinidad.*)

* * *

COFFEE.—Coffee prices have not been lower and fine quality have always sold at once. Ordinary demand was, however, disappointing. Prices per cwt. have been as follows: Blue Mountain Jamaica sold up to 233*s.* 6*d.* for fine bold, Costa Rica 145*s.*, Kenya 115*s.* to 120*s.* Brazil 95*s.* to 100*s.*

* * *

TEA.—Early in September the *Times Trade and Engineering Supplement* stated that Java had increased her exports greatly since the Empire preference on Ceylon and Indian tea was repealed; her sales to Great Britain have risen from 29,463,035 lb. to 38,848,749 lb. On 21st September it was reported that the imports for August showed a 12 per cent. increase on the total year's receipts. Contrary to expectations prices are not lower. Latest averages are Ceylon 17.51*d.* Indian 14.57*d.*, Java 10.71*d.* Sumatra 12.36*d.* Darjeeling 23.35*d.*

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows:—

| | *d.* |
|---|---|
| 14th September .. .. | 10¼ |
| 19th September .. .. | 10 5/16 |
| 23rd September .. .. | 10 3/16 |
| 25th September .. .. | 10⅛ |
| 30th September .. .. | 9¾ |
| 3rd October .. .. | 9½ |
| 7th October .. .. | 9¾ |
| 11th October .. .. | 9 15/16 |

At the beginning of September the market had declined under the influence of many shipments from Malaya but up to the third week of that month fluctuations were only slight. The *American Questionnaire* figures confirmed the decrease in tyre stocks in July.

* * *

LIME PRODUCTS.—*Lime Oil.* Sellers of hand-pressed at 70*s.* but buyers are holding off. Distilled is quiet but firm with no change in quotation (£25 *c.i.f.*). *Lime Juice.* The small supplies of concentrated are neglected, and the quotation is now nominal. Raw is lower with a small spot sale at 3*s.*, and for shipment at 2*s.* 9*d.* to 3*s.* *c.i.f.*—(*West India Committee Circular* 19th September.)